CARBON PHOTOGRAPHY MADE EASY

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BY

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"Blind Algerian Beggar
Neg. by A. L. Henderson,
Printed on Illingworth's Italia
Carbon Tissue.

CONTENTS.

on a course of laboratory experiments He takes up photography for its results, and he wants to reach these by the quickest, easiest, and best processes

The blue print, requiring nothing beyond printing and washing in plain water, seems to be at once cheapest and easiest in manipulation But oh! the colour! To say nothing of an absence of that delicate gradation in the half-tones which forms so much of the charm of a good photograph Even the least ambitious photographer soon wearies of the chalky whiteness and the blueness of these prints They pall on him

Well, next after blue printing in this vital matter of simplicity is the carbon process That is not a fact generally known, however, and it is the object of this little book to emphasise it

Now to the professional photographer must appeal these virtues of simplicity and freedom from such involved and little understood processes as gold toning and making the print reasonably permanent by fixing and getting rid of the hypo afterwards, the conditions of which skilled chemists are still unable to lay down with real certainty But there is another inducement in carbon on which even more stress may be laid This is the absolute uniformity of colour in carbon prints Silver prints, unless made with the greatest care

and skill, vary slightly in colour or tone, as well as in depth of shade, and any irregularity in this respect is apt to be commented upon unfavourably by sitters. With carbon, no matter who is set to turn out a dozen or a hundred prints, not one of them will differ from another in colour.

What amount of credit is likely to be associated with the name of a professional photographer appearing on the mount below a faded silver print? What impression will be produced in the minds of those who, being unacquainted with the technicalities of photography, compare a carbon print by one professional worker with a silver print of ten years' standing (perhaps already commencing to fade) by another equally competent photographer? That impression must be adverse to the silver printer.

If we look to the example of any artistic professional—one of those whose work commands high prices—we shall find that, nowadays, he has begun to use carbon printing almost, if not quite, exclusively. The amateur whose reputation is high in the photographic world, and whose pictures are at the big exhibitions, employs the carbon process almost invariably.

The object with which most photographic prints are made is to preserve and transmit pictorial records of what is passing. Every experienced photographer knows in his own

hazard, whatever he may choose to say about it, that this object cannot be attained with any degree of certainty by means of silver paper As a matter of fact, we think the absolute permanence of carbon printing should recommend it with irresistible force to both the professional and the amateur To all, in fact, who can appreciate the satisfaction of doing sound, honest work—the best of its kind

The improved papers and materials now supplied coated by elaborate machinery under the most expert supervision, leave no excuse for those who still continue to stigmatise the carbon process as a troublesome one And for the results to be obtained, we say—we repeat without any fear of contradiction—the carbon print has a beauty and permanence that, taken together, cannot be equalled by any other photographic method, in fact, the all-round supremacy of "carbon in its present perfected form is not to be denied It has well been said that this process unites the advantages of the three other best known photographic printing methods It has the simplicity, almost, of blue printing, it has all the richness and delicacy of tone characterising silver, and has the permanence of platinum, while over and above all these is a range of colour that is all its own

I have endeavoured in this book to fulfil

two objects In the first chapter to give complete instructions sufficient to enable anyone who has never made a carbon print before to make one by the easiest and most direct method In the subsequent chapters I have tried to include everything that the carbon worker may at any time want to know about his process, and to give in greater detail its many modifications In doing so, it need hardly be said this work must be largely indebted to its predecessors, both English and German, and to the photographic press I have consulted, as far as I am aware, every book upon the subject that is available At the same time the working directions for all the commoner methods are based upon the result of my own experiences during a good many years

In conclusion, I would add a few words on a matter of business As my readers doubtless know, I am a manufacturer of carbon tissue, transfer papers, and all materials for the process In common with most Englishmen, I strongly object to read a book full of references to and puffs of the goods of some particular maker I have therefore carefully abstained from doing so in my own case, and the reader can go through from the beginning of Chapter I to the end of Chapter XII. without fear of encountering references to Illingworth's this, or Illingworth's that. I

prefer, instead, to say here once for all that the materials referred to throughout the book are those made by my firm, Thomas Illingworth and Co., Ltd., of Willesden Junction, London, N.W., from whom they can be obtained at prices which are given amongst the advertisements at the end of the work. The greater part of the book is necessarily of a general character, and applicable to any of the excellent products on the market, but when a statement is made which is necessarily limited to some particular make, the make referred to is that of my firm.

THOS. ILLINGWORTH.

Willesden Junction, February, 1903.

CHAPTER I

Giving an Outline of the Process and Full Directions for Making a Single Transfer Carbon Print on Ready Sensitised Tissue

In this first chapter I propose to give all the directions which may be necessary to enable anyone, who has never attempted to do such a thing before, to make a carbon print The variations in the process are almost endless, and with each of these I shall deal in subsequent chapters, but there will be no need to refer to these at all, if the worker is satisfied with what are called single transfer prints on ready sensitised tissue—a form of print which is in every single respect but one, and that a very slight and often immaterial one—the most beautiful and the most permanent that photography can produce

The carbon process depends upon the fact that gelatine, which, as everyone knows, swells up in cold water and dissolves in warm water, when mixed with a bichromate and exposed to light, loses this property of dissolving in hot water, and in great measure also ceases to swell up in cold If we mix some finely ground colouring matter

with a little gelatine dissolved in hot w
and add to the mixture some bichrom
say potassium bichromate, and pour thi
glass and allow it to dry in the dark,
have at once the cheapest and the simp
sensitive film that could be desired I
not so sensitive, of course, as a dry p
but in such a case as we have describe
about as much so as a piece of P O P
we were to expose such a coated glass ur
a negative, glass side towards the film
of the negative, for about as long as wo
be required by a piece of P O.P., and v
then to soak it in cold water for a
minutes, following this by warm water,
should find that when it was put in
warm water, in those parts where the h
lights in the negative prevented the l
from getting through and making the g
tine insoluble, the gelatine washed av
bringing with it the colouring matter
mixed with it Where the light had b
able to get through and act, on the ot
hand, the gelatine would not dissolve,
in the places where a little light only ac
some would dissolve and some would
In this way we should get a transpare
from our negative, clear glass in the higl
lights, while the deepest shadows would
represented by a mixture of the gela
and colouring matter used Such a tra
parency would only necessarily have

defect As the film was separated from the negative by the whole thickness of the glass, it would not be sharp

Why! asks the reader, why not put the coated glass and the negative film to film? In the answer to this lies the whole kernel of the carbon process Let us suppose we were to do so, what would result? In fig 1 I have sketched the first state of

FIG 1

things described, except that I have very much enlarged the thickness of the layer of gelatine and colouring matter, in order to make clear what goes on No matter what the negative may be, if it is a good one some trace of light must get through the deepest parts of it, and so that part of the sensitive film next the glass will, to a certain extent, be made insoluble The more transparent that part of the negative that is against it the further into the film will the insolubility extend After exposure the state of things is something like that in fig 2, in which the heavier shading

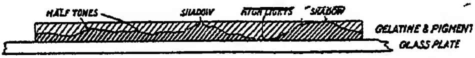

FIG 2

indicates the part of the film which has been made insoluble I have indicated by

means of arrows parts of the film which will form (1) high lights, (2) half-tones, and (3) shadows in the finished prints Putting the glass plate in warm water, the soluble gelatine dissolves, and we get left a film as shown in fig 3 If we had exposed our

FIG 3

sensitised glass with its coated side towards the negative, we should have the insoluble side of the film also next the negative, and

FIG 4

not next the glass which has to support it When we put it in hot water to wash away the soluble gelatine, we should be left with a clean glass plate, as shown in fig 5, and

FIG 5

a loose film of gelatine not connected with it in any way, which would promptly break up and probably flow away down the sink For this reason we could not apply our mixture of the gelatine and pigment to paper and develop it by merely immersing it in hot water, which seemed at first to be an insuperable difficulty in the way of the process becoming practical

This difficulty is got over by what is known as "transferring" Paper is coated with the gelatine, pigment, and bichromate, and in that state is called "sensitive carbon tissue" It can be bought "insensitive," that is, without the bichromate, and sensitised by immersing it in a solution of bichromate a few hours before it is to be printed, and then drying, but this we shall deal with subsequently The tissue is printed by having its gelatine surface placed next the film of the negative in the printing frame, which is then exposed to light in the usual way

When printed, the tissue is put into water, along with a piece of prepared paper called transfer paper, and the two, when wet, are squeegeed together, left a little while in contact, and then placed in warm water The paper on which the gelatine was originally coated can then be pulled away, as the film upon it is soluble on the side next the paper, as shown in the case of the glass in fig 5 The warm water gradually washes away the soluble gelatine, leaving the finished picture upon the transfer paper, which has only to be alumed, washed, and dried

These stages are shown in the following diagrams In fig 6 we have the carbon tissue (greatly magnified, of course) just as we had the glass plate bearing the gelatine

in fig 1 After printing under a negative, as in fig 4, we have the tissue, as in fig 7,

Fig 6

with part of its coating insoluble, but still with plenty of soluble gelatine next the

Fig 7

paper Fig 8 shows us the state of things after applying the transfer paper, with the original paper partly stripped off, and fig

Fig 8

9 shows us the developed print on the transfer paper (Compare this with fig 5 to see the need of transferring)

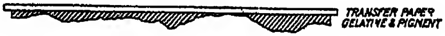

Fig 9

The process, it is clear, is simple enough in outline The question is, is it simple in practice? I can only express my firm conviction that the entire production of a first-class carbon print is a much easier and simpler matter, requires fewer directions, calls for less skill and practice, and presents fewer opportunities for error, than

does the mere toning and fixing of a silver print.

First as to the apparatus required What I here give, it must be remembered, is a *minimum* for getting perfect prints When the photographer has tried the process, if he likes it, and determines to go on with it, as he is almost certain to do, he will no doubt want to go in for more elaborate appliances, which will not make his prints any better, but will enable him to work with greater speed and comfort The minimum of apparatus, it will be seen, is a very small one

A flat squeegee, a little longer than the greatest dimension of the prints to be made, a squeegeeing board, which may be a flat board, larger than the prints, covered with a smooth sheet of zinc, but the bottom of a porcelain dish or a sheet of plate glass or even a plain smooth board will do, a few sheets of blotting paper, a few dishes, and two printing frames Probably the only articles of all these that he will have to buy will be the squeegee As far as the materials are concerned he will want a packet of sensitised carbon tissue, a packet of transfer paper, plenty of hot and cold water, a few small pieces of P O P, and a five per cent solution of alum The tissue may be of any colour he wishes his final prints to possess, carbon tissue is supplied in fifty or more tints The transfer paper

in like manner may be white or tinted, rough or smooth, just as he thinks fit.

Now the actual instructions are few. The sensitised tissue does not keep in good condition for more than a few days, say a fortnight as the limit, so it must be used while fresh. (When the photographer takes up carbon work definitely he will no doubt elect to sensitise his own as he wants it.) It must be kept in the dark, and the packet only opened in subdued light, of course, remembering that it is a little more sensitive than ordinary silver paper. It can be put into the printing frame in an ordinary room with the blinds down. If it is to be kept for as long as possible it should be borne in mind that warmth and damp are what cause it to spoil most quickly, and it is best kept packed flat under pressure. A printing frame with a piece of glass in it is an excellent utensil for storing it.

To print we take the negative and with a little gum and brown paper, or lantern binding strips cut right down the middle so as to be only half the ordinary width, put an opaque border all round on the glass side. An easier method is to have a piece of clean glass the same size as the negative with a border stuck on it, and to put this into the printing frame first, border next the negative; such a piece of glass will then serve for all the negatives that size that are to be printed, without further trouble.

Then putting the negative in the printing frame, we place on it, in contact with it, a piece of the carbon tissue, and then put the back of the frame in, in its place

Sensitive carbon tissue is curious stuff to look at It shows on one side the paper support, stained yellow with the bichromate in the film, and on the other looks black and horny from the coating of gelatine and pigment on it As in this condition, whatever the colour of the pigment almost, the layer looks black, it is well to write on the paper side in pencil, lightly and in the corner, the colour of the tissue, so that if different colours are bought they can be recognised one from the other It is this black side of the tissue that is put next the film of the negative in the printing frame

No sign of the image can be seen as printing progresses, but this, so far from making carbon printing harder than any other, is, in my opinion, at least an advantage It is quite simple to ascertain exactly how long to print, either by means of an "actinometer," as will be described later on, or by the following plan A negative is selected of about the same colour and density as the one which is being printed in carbon, and is put in a printing frame with a little piece of P O P behind it A square inch of P O P is quite sufficient The two printing frames are then put out to print side by side in the same light There is

no need to look at the frame containing the carbon tissue at all, but when the P.O.P. has printed out to the exact depth a finished print on P.O.P. ought to have (not to the depth it would have to be over-printed to be right when toned and fixed), the carbon print is done.

This rule will be found to give at once prints which are almost, if not exactly, right; there will be very little indeed the matter with them, as far as exposure is concerned at any rate, and if the first piece of P.O.P. is kept and marked, the next print may be made a shade darker or lighter if it is found necessary, with no trouble at all. It is best to carry out the other operations required to finish the print immediately after printing, as the action once started by the light goes on in the dark if the print is kept undeveloped, and what was correct printing in the morning might turn out to be over-printing if the development was postponed till night, especially in warm damp weather. Accordingly, we have ready a dish of clean cold water, and lying in it, face upwards, is a sheet of transfer paper a little bigger than the piece of tissue. The beginner very unfamiliar with photographic processes may be in a little doubt as to which is the coated side of the transfer paper, especially when it is wet. For this reason it is best to look at it well before wetting it (it is, of course, not sensitive) and

to put a pencil mark on the back The front or coated side may be recognised by a slight shininess due to the gelatine or sizing on it, by the fact that it is evidently the finished or better surface of the two, and by the fact that if the paper has any tendency to curl at all it curls with the coated side inwards.

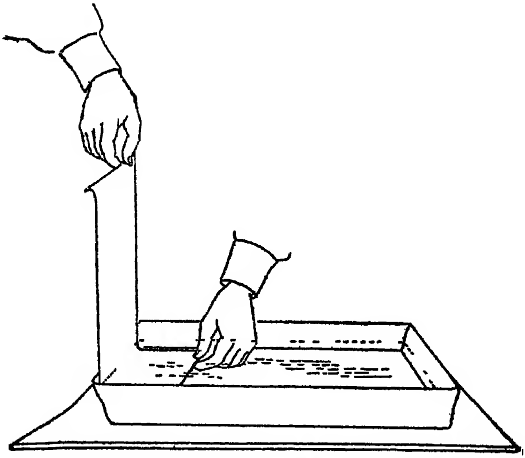

FIG 10—SHOWING HOW TO IMMERSE THE TISSUE

Ordinary transfer papers need only to be put in the water two or three minutes before they are wanted, thick and rough papers are better for soaking for an hour or two first The tissue is taken out of the frame in subdued light and immersed face downwards in the water (fig 10) If there are

any bubbles on the back of it they may be broken with the finger, or, if there are many, the squeegee may be passed over it very lightly once or twice The tissue is turned quickly over to see that there are no bubbles on the face of it, and then is allowed to curl up It curls with the black side inside In a few moments it begins to uncurl, and this should be watched for As soon as the uncurling is noticed, the tissue is turned

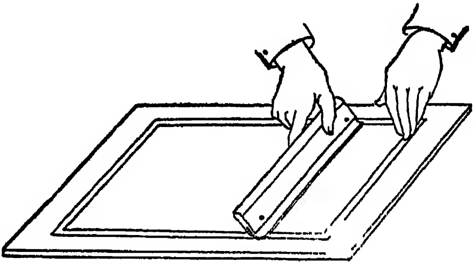

FIG II —SQUEEGEEING THE TISSUE

over, so that its black side is in contact with the face of the transfer paper, adjusted in position on it, and then the two should be lifted out of the water together, and placed on the squeegeeing board with the tissue uppermost Three fingers of the left hand should be placed on one edge of the tissue to prevent it slipping, and the squeegee passed lightly (fig 11) a few times from the fingers across to the other side of the tissue The board then may be turned

round, and the squeegeeing repeated until it has been done in each direction in its turn Squeegeeing must only be done very lightly at first, but when the tissue no longer has any tendency to slip it may be more vigorous, but need never be violent After getting tissue and transfer paper in good contact, they may be placed between pieces of blotting paper (a weight put on them for preference), and be put aside for a quarter of an hour

In the meantime preparations may be made for development This sounds formidable, but it only means getting together a couple of dishes—one with cold water and another with water just as hot as the hand can bear, but no hotter—and having a kettle of boiling water handy, if the hot water in the dish should cool too soon The transfer paper and tissue, which should now be adhering firmly together, are slipped into the warm water, tissue still uppermost, and left there for two or three minutes. Almost directly the black pigment and gelatine will begin oozing out from between the two papers Leave it to do this until it seems to be coming out very freely, and then, holding the transfer paper to the bottom of the dish with the left hand, pick up one corner of the tissue with the right and pull it gently off, taking care to keep both well under water This can easily be done, by keeping the tissue

well folded back (fig. 12). When it is pulled right off, the shiny tissue may be thrown away; it is done with.

We now have the transfer paper with a mass of black-looking substance adhering to it, lying under the hot water, and if it is left so lying for a quarter of an hour or so the picture will develop itself; that is to say, the soluble gelatine will dissolve in the warm water, making it very dirty, but

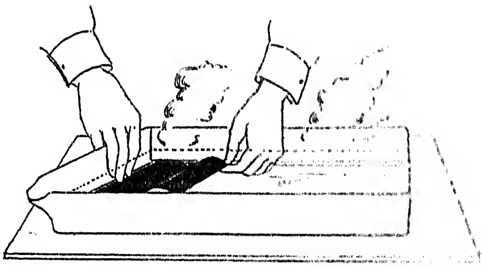

FIG 12.—REMOVING THE PAPER.

this does not matter at all, and the insoluble gelatine will adhere to the transfer paper to form the picture. There is no actual need to let the print develop itself in this way, and it can be helped by slipping under it a sheet of glass, and holding the print by its edge to the glass, raising the glass at an angle and pouring the warm water over the print from a jug or cup, as shown in fig. 13.

The soluble gelatine very soon washes away, and we have a print which presents

the appearance that it is to have when finished The greatest care must be taken in these processes on no account to touch the face of the print with the finger or anything solid, except on the edges that may be trimmed off

When the print is developed, it may be put into the dish of cold water until the alum bath is ready Some five per cent. solution of ordinary alum being put in a

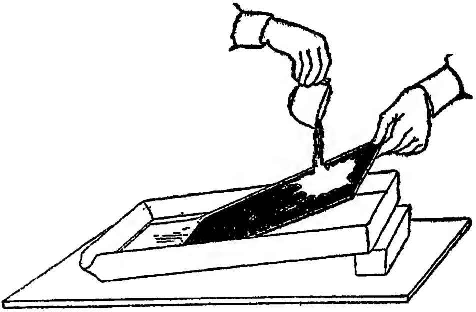

FIG 13 —DEVELOPING THE IMAGE

dish, the print is allowed to remain in this for five minutes It is then taken out, washed in three or four changes of water, allowing five minutes for each, and the finished carbon print is then hung up to dry The alum solution is made with boiling water and allowed to get cold before use

I hope I have said enough to show that it is a simple and easy process There are

very few precautions that need be mentioned at this stage The sensitive surface of the tissue should on no account be touched with the fingers The water for development should not be too hot, or blisters may be caused The fingers should be well washed and the nails brushed after using bichromate, or putting the fingers in a bath containing it, as is done when first wetting the tissue and when developing The prints when done should be hung up to dry and not blotted Other instructions will be dealt with subsequently, but there is little more to say regarding the production of a *single* transfer print that is necessary

Owing to the transferring, it will be noticed that our print is reversed as regards left and right Printed matter can only be read on such a print with the help of a looking-glass For landscape purposes, this usually does not matter, but for architectural subjects and in some portraits, in copying, and so on, this reversal is not permissible In such cases, we must either use a film negative and print from the reverse side of it, or must use a reversed negative, or must adopt the double transfer process With film negatives nothing further need be said, the film is simply put in the printing frame the other way up Reversed negatives can be made by cleaning the glass side of the dry plate very carefully and ex-

posing the plate in the camera through the glass, allowing for the thickness of the glass when focussing, or by fitting to the lens a reversing mirror or prism In most cases, photographers will adopt either the use of film negatives or of the double transfer process, with which we shall deal subsequently

CHAPTER II

The Carbon Tissue

Before entering on fuller descriptions of the various applications of carbon printing, we must deal with the constitution of the tissue itself, which is the basis of the picture with some other necessary materials of carbon printing and with the few requirements of a carbon printer in the way of special apparatus

The preparation of carbon tissue by hand is a tedious undertaking Few of our readers will care to be bothered with it, and still fewer will be well advised to risk that precarious outlay of time and temper which amateur tissue making, with all its glorious uncertainties, demands However, we now and then meet with an amateur who chooses to experiment for himself in this line, and for the information of such, a simple and tried formula and working directions may not be out of place

Twenty parts of gelatine are soaked for a few hours in from sixty to eighty parts of water Heat is then applied to melt it, and five parts of sugar-candy are added A little stirring readily suffices to bring the whole into solution The colouring matter

(in quantity not exceeding about one part) is then to be added This colouring matter may be carbon in some convenient form, such as Indian ink or ivory black, or any other of those colours, such as the ferruginous reds and browns, which are equally as permanent as carbon, may be employed As colouring matter is added to the dissolved gelatine, and, of course, very intimately mixed, tests should be made in the following way A small strip of somewhat translucent white paper, such as a common writing-paper, is floated for a moment or two on the surface of the pigmented gelatine, and being removed is hung up by one end until all of the gelatine that will run off has done so If, thus, the coated part still appears more or less transparent to the light of a lamp, further addition of pigment is to be made Pigment is to be added until the film formed as described is quite opaque to such light as is transmitted by the paper If the intention is to produce a film suitable for transparency making, about fifty per cent more than the quantity of pigment thus arrived at should be added, for in a transparency the light which gives rise to the visible image only traverses the film once, whereas in the ordinary print on paper, viewed by reflected light, the rays traverse the film, and, being reflected by the white ground, again pass through it, sub-

ject for a second time to its absorptiveness, before reaching the eye of the observer

It is important to use only the most finely-ground pigment in this work For instance, in the case of Indian or Chinese ink, the best quality should be selected, should be finely crushed in a mortar, just covered with water, and left for twenty-four hours in soak" At the end of that time, an addition of a little boiling water, and a further application of heat beneath the vessel containing the Indian ink, will readily bring it into suspension in the form of a smooth paste suitable for mixture with the gelatine solution already prepared Other colouring matters may be chosen, of course One is not by any means confined by the use of carbon, as has already been stated, but it is well to remember that, while some mineral pigments have been known to resist an appreciable change through hundreds, and indeed, thousands, of years, other modern "artists' colours," which are handsome enough in their way while freshly prepared, are deplorably short-lived, they succumb very quickly to the malign influence exerted by them by sunlight and by moisture and the impurities of the air And as the vehicle of carbon printing—hardened gelatine—bears so much resemblance chemically and physically, to vellum or parchment (of which the use for all documents of importance is based on its

remarkable stability), there is every reason to suppose that the durability of a carbon print is limited only by the nature of the "permanent support," and by the character of the suspended colouring matter Such being the case, it would seem little less than a crime to employ any pigments other than those of the stability of which no reasonable doubt can be entertained

The paper employed as a support for the film of gelatine in making carbon tissue must not be strongly sized, or it will not be readily enough permeated by the water used in development It should be tough and have a smooth surface so as to take a uniform coating of the pigmented material. Having been warmed and filtered through fine muslin, the gelatine solution may be simply poured on to the paper, but this is not a very practicable method of applying the coating

Commercially, a band of paper is passed just below the surface of a trough full of the pigmented gelatine, kept at an even temperature by the aid of steam or hot water In an amateur way, perhaps the easiest plan is to clean carefully a glass plate and level it, then pour on a suitable quantity of the gelatine solution, about eight ounces will suffice to coat a plate measuring 17in × 23in After the film has set, a sheet of paper, which while not literally wet is thoroughly saturated with

moisture, is laid down upon it slowly and carefully, commencing at one corner so as to avoid the formation of air bubbles After a little time, a knife may be passed along the edges of the glass plate, and the finished "tissue" removed and dried in a well ventilated and dust-free room.

The use of home-made tissues is, however, impossible in practical work, and it is only described here as an interesting experiment for those who like to do everything off their own bat, as it were It is not only on account of the wonderful uniformity of the coating on machine-made tissues that these are to be preferred, but also for another reason Gelatine is a material of extremely complex chemical structure The physical behaviour of the substance varies to a surprising extent, according to its origin and method of manufacture, so that some brands of gelatine are more suitable and others less so for the purpose of the carbon worker It is often found necessary to mix several of the different commercial varieties of gelatine into a blend the characteristics of which embrace those most suitable for tissue making Moreover, unlikely as it might seem from appearances, a gelatinous solution has "structure," something like the stringiness of a white of an egg, and just as this is destroyed by beating it up, so the structure of the gelatine has to be destroyed by prolonged churning, before it is

fit to be made into tissue It is only by purchasing carbon tissue of a standard maker that the photographer can secure every advantage, as far as his raw material is concerned, which is to be had in the existing state of the process

This tissue is regularly made in some fifty shades of colour, and in addition special tints are made to order, or any desired colour can be matched Some of the most useful shades are

Standard brown A rich photographic colour, suitable for most ordinary work where prints have to resemble silver prints

Portrait brown Another photographic colour, but warmer in shade than standard brown

Engraving black Suitable for copies of engravings, drawings, and enlargements

Platinotype black Useful for both small and large prints, a colour that is exactly the tone of a good platinotype print

Red chalk This is used largely for small portraits, and for reproduction work when what is known as a Bartolozzi red is required

Besides these, some of the more popular are known under the names of Willesden brown, standard purple, portrait purple,

warm black grey black, sea green, Willesden sea green, dark blue, Willesden red, sepia ordinary, Willesden sepia, warm sepia, cool sepia, golden sepia, violet, terra cotta, and Willesden lilac A chart representing eighteen of the principal colours can be got from the makers, and will prove very serviceable to the printer by enabling him to select that particular colour which is best suited to the work in hand

The bands of tissue as sold in the roll form measure 2½ft wide × 12ft in length, but half bands and quarter bands are also to be purchased in any colour Carbon tissue is also to be obtained in all the popular cut sizes

Whether cut or in rolls, the tissue is sold in two forms—sensitive and insensitive If uncertain numbers of prints are to be made in various colours, it will be found cheaper to purchase the unsensitised material, as with reasonable care it will keep in good condition for years When, on the other hand, one can map out the work to be done with some degree of regularity, there is a great convenience in buying ready-sensitised tissue Such tissue is manufactured on certain days in each week, which can be learnt beforehand This enables the photographer, by stating his requirements in advance, to ensure a constant supply of fresh material It is to be carefully remembered that sensitised carbon tissue will not keep

in good condition for more than a fortnight, unless it is placed in a specially-made calcium box or tube, which will preserve it in good condition for two or three months

Roll tissue, whether sensitised or not, should be stored in a dry but not too warm place, and kept from the access of light and air The same thing applies also to the cut tissue, which, moreover, should be stored

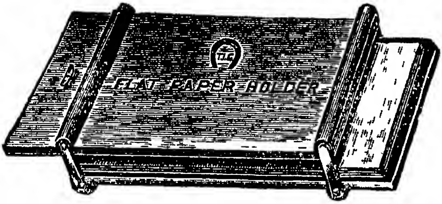

FIG 14 —FLAT PAPER HOLDER FOR TISSUE

away under pressure, otherwise it will develop a tendency to curl up at the edges, and may prove awkward of management in the printing frame As already mentioned, a printing frame can be used at a pinch, but if carbon work is taken up seriously the flat tissue holders and calcium boxes which are on the market will be found economical and convenient for the purpose in question

CHAPTER III

TOOLS AND MATERIALS

As a matter of fact, the materials required for carbon printing are very few, and of a most simple character, as can be seen from the list given in Chapter I

To begin with what is most essential—the squeegee It is possible even to find a makeshift substitute for the squeegee of commerce, but it is certainly not worth while The squeegee is of two sorts—the roller and the flat or scraper form The latter is preferable in all the manipulations connected with carbon printing It is to be had of various sizes, from eight inches to eighteen inches in length In use, it is to be held quite in the middle, so as to exercise a uniform, moderate pressure, and is passed steadily and not too quickly across the tissue, etc As the squeegee is simply a narrow wooden handle with a strip of indiarubber (the bearing surface) let into it, there is no difficulty in keeping it clean, but it is as well to keep separate those which are used in the dark room and for transferring prints.

A jar to hold sensitising solution is the next requirement for those who determine

to sensitise tissue for themselves I recommend a one-gallon stone jar as being convenient in many ways It protects the sensitising solution from light, which is desirable It allows to be stood in the sink a large glass funnel containing filtering material (such as a plug of cotton-wool) through which the sensitising solution that has been used can be filtered as it is poured back into stock, and it holds a quantity of solution that can be relied upon until at least two rolls of tissue have been sensitised in summer or five in winter

Clean white cotton gloves for handling the dry tissue, and rubber finger-stalls for working with the sensitising bath, are worth mentioning and worth having Glass rods with rounded ends, cotton-wool, pieces of sponge, and camel-hair brushes are also useful

The dishes used in carbon printing call for no special description or remark, except that they are better if made rather deeper than is required in other branches of photographic work Those for sensitising may be of porcelain, and exceptionally deep, so that, if desired, some half-a-dozen pieces of tissue may be immersed one after another without "overcrowding," then, the whole pile having been turned over, withdrawn from the solution in reverse order Baths for developing may be appropriately of thin steel

If a drying-box is wanted, it need not be bought ready-made, but can be improvised by any amateur carpenter and gas-fitter Take an ordinary box eighteen inches square, or any other convenient size About a couple of inches below the lid fix a horizontal shelf, hinged in front and extending to within half an inch of the back of the box, its free end being supported by a pair of cleats fixed to the sides of the box, within it Again, about a couple of inches below this, hinge a second similar shelf extending from the back to within half an inch of the front of the box Fix a tubular metal elbow in the back of the box, near to the bottom This elbow is to be connected externally with an upright pipe of larger diameter containing a gas jet Place the sheets of tissue to be dried (not too close together) in the box, shut down the lower shelf, and place on it some porcelain trays containing lumps of calcium chloride, do the same thing with the upper shelf, light the gas jet, and plane off just enough from the front edge of the box to enable the lid to be shut down while the jet burns freely and brightly (showing that it receives from the box a sufficient supply of air) Under these circumstances, air entering by the horizontal slit at the front of the box passes to the back over the upper set of calcium trays, and to the front again over the second set, then traverses

the body of the receptacle, and is withdrawn by the draught of the burning gas jet or candle All of the fittings must be made close—*e g*, with the elastic "draught preventer" sold for doors—as otherwise a part of the air current will escape contact with the drying medium The calcium, after it becomes wet, can be regenerated by roasting it over the fire in a clean shovel Many other patterns of drying box dependent on the maintenance of a current of air have been introduced, also grids, muslin bags, and other receptacles for calcium chloride to be inserted in ordinary cylindrical cases of air-tight boxes for the storage of tissue The chief points to be attended to are Using the calcium in good condition—that is, well baked and therefore dry—and preventing any particles of it from falling on the tissue to be preserved

Temporary support is to be found listed in catalogues, and it will not pay either the amateur or professional worker to improvise this for himself

Permanent supports and single transfer papers the photographer may like to make for himself, and these are described later on Such other materials as are employed in carbon printing we describe in connection with the processes to which they relate

CHAPTER IV

The Sensitising Bath and Its Use

The sensitising operation is by no means a difficult one, and has the advantage that it gives the photographer a certain control over the character of the print that is useful when dealing with negatives of an abnormal type

The sensitising solution is made up in the following proportions Seven ounces of potassium bichromate are placed in a clean one gallon jar, which is then filled with hot water Only the best quality of bichromate should be used, and on cooling a small quantity of alkali is to be added, say eighty grains of ammonium carbonate in the above quantity of solution Instead of the carbonate a dram of liquor ammonia may be employed What is required is to add enough alkali to make sure that the bath is slightly alkaline A slight excess of alkali does no harm If this is more than the photographer cares to trouble to do, the ready-prepared sensitising compound (which is to be had in half-pound and one-pound boxes) can be used

This has to be simply dissolved in water in, approximately, the above proportion

For sensitising, it is best to use a deep porcelain dish, preferably one or two sizes larger than the largest of the cut pieces of tissue under treatment This is filled to the depth of about two inches with solution, and the tissue, immersed face downwards, is left in it for three minutes It is then removed, assisting draining in that process by drawing it over the edge of the bath It is then squeegeed down on a flat surface, or hung up, to dry

When small quantities of the tissue only are to be used, the best plan undoubtedly is to squeegee the sensitised tissue on to a pulp board or ferrotype sheet, such as is supplied for the purpose, and to let it dry thereon If this is done, it can be dried without the use of any special appliances whatever, not even needing to be kept in the dark It may be stood up in any ordinary room where the daylight is not too strong without any fear of injury, although it must not, of course, be exposed to strong daylight This method of drying has other good features about it The outer surface of the tissue which it is most important to preserve soluble is protected by being in contact with the plate, from the injurious action of warm damp air and gas fumes The tissue when stripped off, which can be done without any difficulty when once it is

perfectly dry, comes away with a beautifully smooth surface, which is the best it can possibly have for bringing it into good contact with the negative during printing.

If carbon printing is to be done on a large scale, the tissue is sure to be bought unsensitised, and it will be found necessary to set aside a room for the special purpose of sensitising and drying. This room is best kept at an even temperature of about 70° Fahr. in winter by means of hot water pipes; in summer it will need no heating at all. If gas has to be used for its illumination, every jet should be provided with a flue leading out of the room, and arrangements must be made for the regular passing through it of a current of pure air. In these circumstances, the tissue, of course, will be dried in the dark. On a very large scale, the tissue can be sensitised in bands by passing it round a roller, film outwards of course, under the surface of a trough containing the bichromate solution. An arrangement of rollers removes the surplus sensitising solution, and the tissue is hung up on laths to dry. This is hardly likely to be necessary, however, except in the very largest wholesale printing houses, and in such cases the arrangements would have to be suited to the special needs of each individual firm. Such is very unlikely to occur, and even in the biggest establishment the ordinary method of sensitising in a dish should be all that is required.

In the heat of summer, it may be that trouble will arise through the gelatine of the tissue dissolving away in the sensitising bath This is not a common occurrence in this country, but if it does happen it can only be overcome by employing ice to cool the solution The best way of applying this is by standing the dish containing the bichromate in a larger dish containing broken ice The inner dish must be propped up by its four corners, so that it stands firmly and has ice both underneath and round it If ice is not accessible, nothing remains but to keep the solution as cool as possible, and to sensitise in the coolest room available Sometimes in hot climates the expedient of sensitising late at night or in the small hours of the morning has to be adopted

If the carbon printer intends to utilise the latitude in sensitiveness which carbon tissue affords, he may elect to vary the strength of his bichromate bath between limits that may be fixed at about one and seven per cent This can be done conveniently by adding appropriate quantities of plain water or bichromate to the above-described solution, which has, approximately, a strength of four and a half per cent.

If a hydrometer and hydrometer jar are available, the strength can be estimated from the specific gravity, and as the solution can be used over and over again this is

a convenient method of keeping it in order Approximately—as closely as is needed for practical purposes—a one per cent solution has a density of 1 008, two per cent 1 016, three 1 022, four 1 028, five 1 032, six 1 038, and seven per cent 1 045

Most carbon workers will prefer to make up the sensitising solution in smaller quantities Thus, a five per cent. solution—useful for all-round purposes—requires one ounce of bichromate in a pint or two ounces in a quart of water Ten drops of the strongest solution of ammonia (gravity 880) may be added to each quart of solution, the alkali may be reduced in proportion if for special reasons the quantity of bichromate is diminished Should a two and a half per cent bath be wanted, for instance, only one ounce of bichromate would be taken to the quart, or for one and a quarter per cent solution, to be used in the very hottest summer weather, half an ounce to the quart

There is a somewhat general preference for the use of liquor ammonia rather than the carbonate for the purpose of making the solution alkaline, but it is without any very obvious reason, so the carbon worker may well be guided entirely by his own convenience in this matter

Other suggestions, which are practicable enough, but offer no serious advantage, relate to the substitution for the potassium

salt of ammonium bichromate and other compounds For example, by adding a large quantity of liquor ammonia to a solution of potassium bichromate—sufficient to turn it a bright yellow colour—a sensitising bath is obtained which yields tissue in every way satisfactory, except that it prints a little slower than the ordinary To multiply workable recipes would be an easy matter, but the differences of behaviour shown by these various baths are less marked than those to be obtained by varying the strength and temperature of the ordinary stock solution The temperature of the bath, we may say here, should not be allowed to fall below 50°, nor to rise above 65° Fahr

Before discussing the effects of variations in procedure, I will describe fully one method which can be recommended with confidence to the beginner So as to avoid any troubles due to the impurities sometimes met with in potassium bichromate, let us employ the special sensitising compound in the proportion corresponding to the first formula given above No addition of alkali need be made, and the method of solution should be that employed with ordinary bichromate, namely, as follows

The proper quantity of the salts—for a couple of quarts of solution, say three and a half ounces—is suspended in a piece of clean muslin tied over the mouth of the

vessel in which solution is to take place This muslin is allowed to sag in the middle, dipping down into the jar below that level which the water will take when the proper quantity of it is contained Then boiling water is poured over the muslin and the salts contained in it, as through a strainer, with the result that a good deal is done towards bringing the salts into solution. They are finally dissolved, as the liquid cools, by the action of gravity bringing fresh fluid continually in contact with the crystals As the salt is taken up, the density of the liquid is increased, and it is caused to sink to the bottom of the vessel, thus bringing less highly-charged solution in contact with the crystalline matter to be dissolved This is, it need hardly be said, a matter of convenience only, to save time in the completion of the operation If prepared as described, it will generally be found that the solution is fully charged with salts, ready for use, so soon as it is quite cold

Some people advise the use of distilled water, and no doubt that would always be advantageous, as guarding against possible harmful impurities in every branch of photography, but it is not necessary If the sensitising solution when made up, or after it has been used a few times, is not quite free from suspended matter, it may be filtered through a piece of cotton-wool or filter paper in a funnel

I may remind the photographer that to avoid dust is one of the most important of his precautions in connection with any process of sensitising, and so forth Loose fibres and stray particles of gelatine are the reverse of advantageous to a sensitising bath

The pieces of tissue are to be immersed face downwards in the solution just described Every care must be taken to guard against the formation of air bubbles or against their persistence if they should occur When it is remembered that sensitising takes place from both sides of the tissue, from the gelatine face and also by diffusion of the bichromate solution through the paper backing, it will be understood that air bubbles adhering at the back will be just as apt to give rise to irregular spots, comparatively insensitive, as if they were on the face of the tissue

There are some persons, having the skin of their hands broken or tender, who suffer from local troubles—the effect of a poisonous action of potassium bichromate Others are much less susceptible to what is called the "bichromate disease", but in all cases it is a proper precaution to wear protective finger-stalls of indiarubber if the skin is chapped or if a considerable number of sheets of paper have to be sensitised An alternative precaution is so to arrange matters that the fingers shall not be dipped

into the solution at all The worker in a small way, who adopts the ordinary precaution of washing his hands after every process involving the use of bichromate, and especially of well brushing his nails, is not likely to have any trouble in this respect at all

While one edge of the piece of tissue is raised, that edge opposite to it is immersed in the solution, and pushed forward until the whole has been brought under the liquid As the back of the tissue is not delicate, a stick or a glass rod may be used freely to assist in this operation A broad camel-hair brush is passed over the back of the tissue to remove any adhering air bubbles, and it is then turned over and the face attended to in the same way Finally it is turned over once more with the pigmented side down The time of immersion should not exceed five minutes, three are sufficient, and a three-minute egg-boiler will usually prove a reliable guide in this climate The tissue is removed from the dish by drawing it from the edge that was first immersed, over one of the rounded edges of the dish, the object of this being to remove as much as possible of superfluous bichromate solution The pigmented face of the tissue is put down on a sheet of polished ferrotype plate or talced glass, and a squeegee applied to the back to remove excess of moisture, and the tissue

pressed in close contact with its support. It is then put aside to dry

Besides the use of the soft brush or sponge to remove air bubbles during the actual sensitisation, it is advisable to employ similar means for removing dust from the surface of the tissue prior to immersing it, and, after drying, before placing it in the printing frame At the same time, the other aspect of photographic cleanliness—chemical cleanliness—must not be lost sight of, and appliances such as brushes used in connection with the bichromate bath should be kept for that purpose and no other

A further, but rather dubious, advantage which has been claimed for the method of drying tissue just described is this The longer sensitised carbon tissue remains moist, the less readily soluble it becomes Now that part of the film which is pressed in contact with the ferrotype or ebonite or glass plate necessarily dries more slowly than that part which is next the paper support, through which all evaporation must take place Thus it is said that the face of the tissue will become less soluble than the back, and that this is precisely that condition most favourable to success in the printing operation

With large pieces of tissue, it will sometimes be found handier to bend the tissue into a convex shape, pigmented side down-

wards, and so to put it in the bath that it touches the solution in the middle first, lowering the two ends immediately—but not so quickly as to cause any splashing—and so to avoid the accumulation of air bubbles A glass rod may be used to facilitate manipulation and save immersion of the fingers by raising one end or one corner of the tissue when required As practice makes perfect in the quick and uniform saturation of the tissue, it will be found easy to deal with three pieces at one and the same time After the expiration of a minute from the immersion of the first sheet, a second may be placed in the tray, and after two minutes a third At the end of three minutes the first sheet is withdrawn and a fourth introduced, and so on, and in this way a dozen pieces of tissue can be sensitised within a quarter of an hour On removal from the bath, the tissue may be laid face down upon a sheet of glass, zinc, or any other smooth surface, and lightly and quickly squeegeed to render the back surface-dry It may then be raised (the tissue will not stick if the operation is performed quickly enough), placed face upwards on a sheet of blotting paper, and put, face upwards, to dry across an arched card standing in the shape of an inverted U Alternatively, the squeegeed sheet of tissue can be hung up by means of clips to dry, and by means of similar clips a weight in

the form of a wooden lath can be attached to the lower edge of the sheet, so as to check curling If a sensitising bath having rectangular sharp edges happens to be used, naturally the tissue cannot be drawn out for the purpose of drainage in the way previously described In this case, a length of glass tubing or rod should be placed across the bath, close to and parallel with one of its edges, and the film drawn over this

The use of a strong sensitising bath has a tendency to make the gelatine insoluble without exposure, in other words, it has an effect similar to that of "sunning down ordinary prints Therefore, if we have to deal with harsh negatives, unduly strong in contrasts, it will be apparent that the use of a strong bichromate bath may be an advantage Still further in the same direction can we go by floating the pigmented gelatine surface on the sensitising bath, thus making the film relatively hard in that outer stratum where the delicate half-tones are to be formed Or if, on the other hand, we have not to deal with a hard but with a weak, flat negative, more vigorous prints may be secured by floating the paper back of the tissue on the sensitising bath This produces a local hardening at the back of the film, tending to accentuate the deeper shadows It is much better, whenever possible, not to resort to these devices, how-

ever, but to get the negatives right in the first instance and to use the process in a straightforward manner

The time of immersion in the sensitising bath is a matter that is not unimportant, and we may mention here that all cut pieces which are intended to form part of the same batch of prints from a given negative should be treated alike, otherwise they can not be expected to print uniformly The resulting prints may be greatly influenced bv the time of immersion The great point to be kept in view is that the tissue must remain in the bath until the pigmented gelatine is uniformly softened, indicating that the film has been equally impregnated throughout The amount of soaking necessary must depend on the nature of the gelatine film and the tetxure of the backing, at the same time an immersion of three minutes in a four and a half per cent solution will be found to be about the normal

Some workers preach the desirability of using two baths—a weaker for summer and a stronger for winter—and there is no doubt that in a strong bath, used too warm, the gelatine film is liable to be attacked The simplest prevention is to use the thermometer and see that the bath does not become unduly heated Beginners are not well advised to introduce into their operations a number of variable factors, whose relative importance they cannot be taught to estimate from any book.

Among the minor additions to the bath that have been suggested is that of glycerine, to prevent the film from becoming too brittle after drying, also carbolic or salicylic acid, to act as preservatives of the gelatine We do not recommend these or any other additions Nor do we recommend, as some do, substituting alcohol for part of the water of the sensitising bath

The drying of the tissue is an operation of great importance, and should have special attention It must not take place too quickly or too slowly, and, above all, must not be conducted in an atmosphere contaminated with noxious gases or sulphurous products of combustion Should the drying be completed in less than four hours, the tissue is apt to prove too insensitive for satisfactory use, and, on the other hand, should it occupy longer than twelve hours, the film is apt to become insoluble making transferring difficult, and giving to the prints an over-exposed appearance In winter time, any well-ventilated living-room in which a fire has been kept burning during the day may be appropriated at night to this purpose The sensitising may be done by gaslight, candlelight, or subdued day light, and the cut pieces of tissue, hung or pinned to a clothes' horse or in a similar manner, may be set up at about five or six feet from a low fire, they will be properly

dried, shown by their crispness, before morning. A necessary precaution is to close the shutters before leaving this "drying room" in darkness, so as to guard against access of the morning light; and if at the same time the door is locked and the key put in the pocket, no harm will be done, and mysterious disappointments may be prevented.

In summer time there is sure to be a room warm and dry enough for the purpose without artificial heating. Or, of course, a specially-constructed drying-box can be employed—one admitting a current of air over trays containing calcium chloride—but it is not necessary.

A word of caution may be added against drying tissue in the dark room used for developing. This is ordinarily about as unsuitable a place as can be imagined for the purpose, for obvious reasons, in which chemical dust, gas fumes, and doubtful ventilation may be included.

In the storage of the dried, sensitised tissue, the important points are that it shall be kept flat and free from the access of light and moisture. It may be put in black paper envelopes, enclosed in an air-tight box, or in one of the flat paper holders made for the purpose. If one of these holders is enclosed with calcium chloride in an air-tight box, the contained paper may be kept good for a great length of

time—three months or more—but in the ordinary way, simply preserved in a dry place, it may be relied on to keep for about a fortnight. The tissue is at its best three days after sensitising. To test if a sample of tissue is too old for use, immerse a little piece of it, without previous exposure, in a little warm water. The temperature of this water is to be gradually raised, and if the film does not dissolve at 110° or 120° Fahr. it is to be discarded as useless.

CHAPTER V

PRINTING UPON CARBON TISSUE

Having procured a supply of cut tissue ready sensitised for use, or having prepared it for one's self by the method described in the preceding chapter, the next step is to provide the negative that is to be used with what is termed a "safe edge," to ensure that the edges of the tissue shall be protected from light and left in a more or less soluble condition Without this precaution, the pigmented gelatine film would be apt to stick more tenaciously to the edges of the tissue backing than to the transfer A black varnish and an edging brush are supplied as a simple means of applying a narrow safe edge to the glass side of the negative Masks of opaque paper may be used Lantern slide binding strips, as already described, may be cemented to the glass of the negative or to a separate piece of glass adjusted in front of the glass of the negative in the printing frame The great convenience of such masks is that having once been cut they are always ready for use

When dealing with very thin negatives, it is advantageous to give them (on the glass side, of course) a temporary coating of matt varnish Such varnish can be worked on very effectively with a pencil or other retouching medium, and at those parts which are wanted to print through strongly it can be touched over with a brush dipped in bright mastic varnish which will make the film transparent For large negatives, it is more convenient to use *papier vegétal* or *minéral* A piece of the size of the negative is sandwiched between sheets of damp blotting paper, the glass side of the negative is edged with strong gum, and the damp mineral paper is then laid on the glass and stretched tightly over it so that no creases may be left on drying

A clear vigorous negative, not one having a yellow tinge, is best for carbon printing Solid back printing frames have been recommended, but there is with them some likelihood of the tissue slipping as the frame is closed One of the box pattern (fig 15) frames with strong springs, specially designed for carbon printing, such as is shown in the accompanying illustration, represents what is most appropriate for the purpose under consideration These frames take pads of ordinary blotting paper, or of indiarubber, such as are used for platinotype printing

Next comes the choice of an actinometer or measurer of the length of exposure required to ensure carbon tissue being properly printed We have already explained how a makeshift actinometer can be constructed by any negative of about the same density as that to be printed together with a slip of P O P The uncertainty that arises owing to the number of different

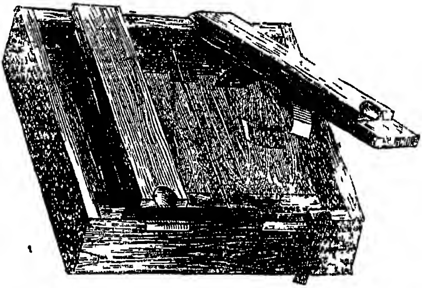

Fig 15 —Box pattern Printing Frame

kinds of P O P on the market just now with different degrees of sensitiveness detracts from the merit of this plan, moreover, it necessitates continually opening and shutting a frame, just as in silver printing, whereas one of the attractions of the carbon process is that nothing of the kind is needed, a simple glance at the actinometer being all that is necessary The principle of every actinometer is the same, namely, to furnish a visible change (or

changes) due to the action of light, corresponding with the invisible change produced by the same light in the tissue This principle and the way in which it is utilised will be made clear by our description of that venerable makeshift—the pill-box actinometer

Having obtained, say, a one-ounce pill-box from any chemist, gum a disc of white paper on the lid and allow it to dry Next turn the lid upside down, and with a sharp penknife make a couple of clean half-inch slits in it parallel to one another and about half an inch apart In the side of the lid, parallel to and near the top of the pill-box, cut a third half-inch slit, the edge of the knife penetrating so far as to make a half-inch cord of the box circle, parallel to the other two half-inch slits Then cut a strip or ribbon, rather under half an inch wide, of any easily-obtained P O P, insert it in the pill-box, draw one end through the three slits in succession, and fit the lid on the box Now one end of the P O P will protrude from the side of the box, while a part of its length (sensitive side uppermost) will be exposed over the white lid Take the "instrument" thus made, out into daylight, and expose it until that portion of the sensitive ribbon lying on the box lid assumes a pronounced colour—one that can be easily recognised, say that of a silver print when one-third printed Wrap up the in-

strument to stop printing at this point, carry it indoors, and paint in water colour on the lid of the pill-box an exact imitation of the tint to which the paper has been printed, so that the painted tint accurately corresponds when *dry* with that resulting from exposure, or at any rate with some tint that the sensitive paper does assume at some stage in the progress of darkening. Now, the amount of light action which corresponds to this amount of darkening is taken to be a unit for the actinometer in question, and is called "one tint." So soon after the exposure of the actinometer as this shade of colour has been reached, we count "one tint," whether the interval of time required to reach that evidence of light action be a minute or an hour. Then we draw out a little more of the ribbon by means of that portion of it projecting from the side of the box—we draw out just enough of it to expose a fresh bit of white sensitive paper on the box lid—and watch for the development of "tint No. 2." The first tint may be reached in five minutes, the second in a quarter of an hour, the third in ten minutes, and so on, according to the state of the weather, but that is of no consequence; what is material is that they represent equal quantities of light action. It remains to be found out how many "tints" registered by this arbitrary scale are needed to print carbon tissue from a

given sort of negative. We may derive assistance, in approximating to this, from the rough method of actinometry already mentioned.

Make a proof on P.O.P. which is somewhat lighter than the finished picture should appear, and note how many tints this printing operation corresponds to on the home-made actinometer. Next, with the same negative, make a print on carbon tissue—to the same number of tints. Develop this print, and, as will appear when we come to consider developing, we shall be able to form a very good idea as to whether it is under or over-exposed. Thus, by careful experiment, data can be arrived at to construct a satisfactory scale for the actinometer.

If all the negatives with which carbon printers have to deal were alike both in colour and gradation, we should fall into the habit of estimating "by eye" our minutes of exposure just as we do seconds or parts of seconds in using the camera. But as the matter stands, and in view of the fact that lighting often varies during the production of a carbon print in a way that it would be most troublesome to keep account of otherwise than by noting actinometric tints, it is not likely that the instrumental means will be supplanted.

There are many actinometers for carbon

printing on the market. Among the light measurers available are Johnson's, similar in principle to the little appliance we have described in the preceding paragraph, Burton's, showing prints from six miniature negatives each denser than the last, Monckhoven's, furnishing a single standard tint after an exposure dependent on the adjustable aperture of the instrument, and others

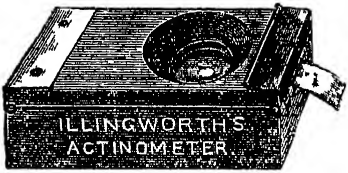

FIG 16

One is inclined to say that there is not much to choose between these instruments—many of them—excepting that the arbitrary scale of one may happen to be more convenient than that of another for the class of work most commonly met with in the printing room Thus the instrument likely to be of most service to a printer must be that one whose scale of graduation fits with negatives of common densities, and with the sensitiveness of the tissue most generally employed

In the illustration given we have an actinometer which is scaled so that a thin

negative will require exposure corresponding to from one to two tints, a medium density negative from three to four tints, and a dense negative from four to five tints, which is a convenient arrangement, the numbers not being on too open a scale so as to sacrifice precision, nor too close, thereby making attendance on the actinometer a nuisance The actinometer also gives quarter, half, and threequarter tints in addition to the whole tints It will be understood that as the negatives are put into the frames, the number of tints proper for each is to be marked on the front ledge of the frame, thus all are to be exposed together, as nearly as may be, and when one tint has been made all the frames marked I are to be turned over, when two tints have been registered the frames marked II are to be turned, and so on Thus the whole process is completed with a minimum of trouble and without any liability to mistakes

Happily for carbon printers, there is a remarkable amount of latitude permissible, as we have said before, in the matter of exposure This fortunate circumstance is to be attributed to the wonderful "control" obtained by a physical method of development Carbon workers should not presume on their immunities in this respect, however, but should aim to make every print represent the strictly normal output of the

frame In other words, by strict attention to the business in hand, "failures" in the day's work should be reduced to *nil*

In the previous chapter it was pointed out that when we have to deal with hard negatives, prints of a soft character may be obtained by using a strong sensitising bath This means that as the tissue becomes more sensitive it tends to softness in printing, to the filling in of detail in the high lights and reduction of contrast Since, then, bichromated tissue becomes more sensitive as it grows older, when we have to print what used to be called soot and-whitewash negatives we can make the best of a bad business by using comparatively old tissue, such as has been sensitised for a week or so And, on the other hand, of course, thin flat negatives should be printed with less sensitive tissue, such as has been prepared only a day or so The increase of sensitiveness of the tissue with age should be carefully borne in mind and allowed for by those taking up carbon printing They will soon become accustomed to estimate it correctly, and will turn it to good account sometimes in the way that has just been described

Another property—this time a very curious one—exhibited by carbon tissue is that of going on printing (so to speak) after removal from the frame into the dark room or storage box This is commonly

spoken of as the continuing action of light, and it necessitates that prints which have received a full exposure must be developed within a reasonably short time Again, it permits of some economy being made in the time of exposure Thus if a number of prints are wanted from a negative in dull weather, we can purposely under-expose them (thus saving time) and let them remain in darkness long enough to complete the "exposure" by the continuing action of light Three or four hours will produce a very appreciable effect, but the interval necessary in each case must be learnt by experience A good plan is to cut the first print taken into several pieces and test one of them by development at intervals of a few hours As the continuing action of light is favoured by moisture, fully exposed prints which have to be kept for any length of time before development should be stored in an air-tight box with calcium chloride

A brief preliminary exposure to strong light or "sunning" of the carbon tissue (for a few seconds only), is sometimes useful in the case of negatives too strong in contrast And this reminds us of the classical warning to carbon printers Never work in direct sunshine unless the tissue is absolutely dry Probably the warning is less needed by thoughtful workers nowadays, as photographers are accustomed to the handling of gelatine surfaces

CHAPTER VI

Development—Single Transfer

Having removed the printed tissue from its frame in the dark room, we shall not be able to discover any indication of an image on it There is a reddish-brown image formed by the action of light in the bichromated gelatine, but, unless the pigmentation of the film happens to very light, it is quite masked But we must not suppose that in this image there is a hard and fast surface of demarcation between soluble and insoluble gelatine On the contrary, the transition from insoluble to soluble is a gradual one at every point, and it is to it that we owe that latitude in exposure which has been referred to The point at which insolubility ends and solubility begins is fixed—the surface of demarcation is determined—by the temperature of the water used for the development of the tissue

Transfer paper is paper which usually requires special preparation before it can be employed for the purpose, and in most cases it will be best to purchase it ready for use There is an ample range for choice

with, for example, fine white Rives, a paper of brilliant whiteness well adapted for small work, toned etching paper, a paper having no glaze on it whatsoever, and giving a broad artistic effect, Willesden crayon, a white paper with a very fine grain, suitable for crayon enlargements, as it affords a very good surface for "working up" by hand, and toned matt, a paper with slight matt grain and a delicate cream tone suitable for all kinds of artistic work These and other papers, such as Whatman's rough, are supplied all ready for use

There is no need, however, for the carbon worker to limit himself to the transfer papers which are supplied commercially Almost any paper can be adapted for use by treatment with a glazing or sizing solution which is easily made and applied

This solution is made as follows An ounce of photographic gelatine is put in a jar containing a pint of water, and allowed to soak for several hours, then a large saucepan is half filled with water, the jar placed in it (covered over, of course, to prevent access of dust), and put on the fire until the gelatine solution is near boiling While the gelatine is still hot, a solution of twenty grains of chrome alum in an ounce of hot water is added drop by drop, stirring briskly while adding the chrome alum to prevent precipitation

The selected paper is pinned to a drawing-board, and, pouring over it a quantity of chrome gelatine solution, this is distributed and worked into the surface with a moderately stiff brush, an old shaving brush answers excellently If the paper is quite rough, it should receive a second or even a third coat, if a perfectly smooth film is wanted, the solution can be distributed with a sponge It is then to be allowed to dry thoroughly before use

The single transfer paper, whether bought or prepared, is cut to a size a little larger than the piece of carbon tissue bearing the print, as in case one of the edges of the transfer paper came within the safe-edge on the tissue it would endanger the stability of the image It is often appropriate to use a piece of transfer paper large enough to serve, when trimmed, for a mount, as well as a support to the print, the margin of the latter being outlined more or less perfectly by the safe-edge mask If a perfectly sharp outline is to be given to the print in this way, the safe-edge of black varnish must be applied on the film side of the negative instead of as described in our instructions on printing This may cause frilling of the print, however, unless great care is exercised in development, and is not to be recommended.

Having provided a large dish of cold water, the sheet of transfer paper is placed

in it, with the prepared face upwards After about a couple of minutes, the exposed tissue, face downwards, is also immersed It is necessary to see that no air bubbles are on either the transfer paper or the tissue If such should occur, they can be removed easily enough by a brush On the immersion of the tissue, it will at first curl up (or, if very dry, even roll up), film inside, as described in Chapter I , but in from half a minute to a minute it will straighten out When this is accomplished, slip a sheet of glass or smooth zinc under the transfer paper, raising it and adjusting the print as nearly as possible in its centre, in which condition print and transfer paper, supported on the plate, are to be raised out of the water and laid on a table The tissue and support are now well squeegeed into close contact The squeegee is to be applied energetically but not violently in all directions It is of no consequence if the edge of the squeegee should rub up a little of the paper backing, but this need not occur The two closely-adhering sheets are then placed between blotting-boards, and subjected to slight pressure under a board

As other prints are transferred they may be similarly placed between blotting-boards —fairly stout boards or several thicknesses of common blotting-paper are necessary in order to equalise the pressure—and in-

serted to make a pile under the pressure board

There is not any precise length of time for which one can state that the pressure ought to be maintained The sheets ought not to be allowed to dry, but that is unlikely to occur for several hours In the ordinary way, a quarter to half an hour is quite long enough, therefore go on transferring as above for half an hour after putting the first print under pressure, then turn over the pile of prints and blotters, and, keeping them still under pressure, withdraw one at a time from the top for development If there are many prints in the pile, it will be as well to insert a zinc plate at intervals for the purpose of equalising pressure

If the transfer paper is rough and heavy, it will be well to maintain pressure for half an hour, using a substantial weight Such paper may also receive a preparatory soaking of twenty minutes or half an hour in the cold water bath (temperature 50° to 60° Fahr) instead of the three minutes that suffice for ordinary light and smooth paper

The developing dish may be very conveniently supported on legs or on a pair of boxes so that a small oil stove, spirit lamp, or gas jet can be placed beneath, with the flame turned just high enough to maintain the water at the proper temperature The

dish should contain to start with water at a temperature of 90° Fahr or a little over, it is best to use a thermometer to fix these temperatures The print to be developed, sandwiched as it is between the back of the tissue and the transfer paper to which it has been attached, is put in the warm water, and all air bubbles are removed Presently it will be observed that the gelatine at the margins has begun to dissolve out and ooze over the projecting edges of the transfer paper When this is well in progress, the temperature may be raised or the print may be transferred to a second tray with hotter water After a few moments in this warmer water, it should be ready for stripping

Holding the transfer paper with one hand so as to keep it under the surface of the water, raise one corner of the backing paper of the tissue with the other hand and attempt to strip it off If it does not come away easily, allow a few seconds' more soaking, and commence at another corner When removed, the paper backing, having upon it a thick, smudgy mass, may be thrown away The glass plate is again brought underneath the transfer paper, and raised out of the bath, carrying the print at an angle The print is then laved with the hot water, taken up from the bath in a small teacup and poured gently over it This will soon clear up the details of the

image, and when development has been carried a little further than seems to be called for from the appearance of the picture, the print is immersed in a basin of cold water, which stops further loss of intensity Those who are accustomed to over-printing silver paper to allow for subsequent weakening may feel surprised at the statement that carbon prints gain rather than lose intensity after "fixing" It is due to the fact that the pigmented gelatine loses transparency as it dries, and so the dry print is a little darker

If there has been gross over-exposure or under-exposure of the tissue, of course that will become evident in the progress of development Of these, under-exposure involves more risk of accident in the ordinary method of procedure The backing strips off very easily, and the under-exposure manifests itself by the fact that the first flow of water clears up the high lights of the picture In such a case, a second dash of equally hot water might probably ruin the print by washing away the whole of the gelatine from the high lights Immediate removal into the cooler water again is what is indicated It may happen with negatives which are harsh and full of contrast that the details of the high lights wash away as has just been described, while the shadows remain actually too dark This should have been prevented, however, by

a preliminary "sunning," as directed already under the head of "Printing"

Of course, if a print is known or suspected to be under-exposed, the proper thing is to commence development, and as far as possible complete it, in water of a temperature as low as 80° Fahr The development should be mainly by rocking, finally clearing up details by pouring on still cooler water

Over-exposure shows itself by resistance offered to the developing process at every stage The backing of the tissue is removed with difficulty, and the lights and shadows remain uniformly clouded Here patience becomes a serviceable virtue, prolonged soaking in water at 130° Fahr or even more may be required to remedy the case Other remedies that have been proved useful are (1) the addition of a teaspoonful or two of common salt to the quart of developing solution, and (2) soaking the print for half an hour in an acidified five per cent solution of ammonium persulphate, and then continuing development.

If only one or two prints have to be treated, and these are from good negatives and known to be about correctly exposed, a less elaborate arrangement will suffice One dish of water kept hot by a lamp or stove is really all that is called for, though two make it easier to establish a good working routine when operating on a con-

siderable number of prints For merely occasional work, a basin of hot water replenished from time to time from the kettle will suffice, provided care is exercised to lift out the tissue on a glass plate when hotter water is to be added, and only to put it back when all the water is at a uniform temperature

The control that can be had by mechanical means in this method of development, without detracting from the "photographic" property of the print, is one of its great attractions, and renders it especially suitable to artistic work Brushwork during the progress of development is, as is well known, capable of yielding highly characteristic results A fine sable brush, either wedge-shaped or pointed, will do wonders in the way of touching up or introducing high lights merely by locally reducing the layer of pigments Many charming effects can be produced by a deft hand in this manner, as well as by the aid of a pad of cotton-wool or even the finger-tips And if the work be done in the earlier stages of the process, any obtrusive evidences of interference are likely to disappear altogether in the after general development When solid bodies, such as brushes or fingers, touch the delicate surface of the film, however, the very utmost care will be required if the print is not to be ruined, as it would be by a single rough touch

The chemist's "washing bottle" is a means by which a fine stream of heated water can be obtained readily, and it is sometimes a useful adjunct to the ordinary dashing or laving of the print with cupfuls of hot water, or a kettle can be used, as shown in fig 17 In some establishments where carbon printing is extensively carried

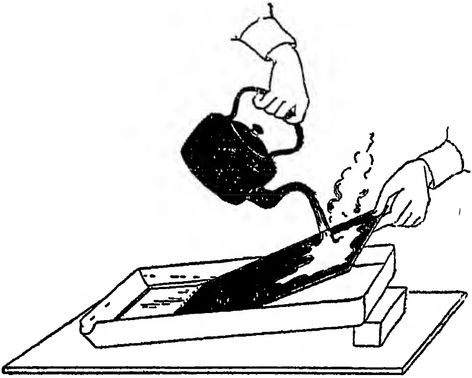

FIG 17—LOCAL DEVELOPMENT WITH HOTTER WATER

on, special arrangements are made to provide jets of water as hot as may be required for developing and local reduction Delicate clouds can often be saved by local development of the foreground with hot water, followed by general development in cooler water, indeed, there are few cases in which the carbon printer does not meet with opportunities of perfecting his

work which are denied to, or far less easily attained by, those whose medium is silver paper

The "fixing" process, with carbon, is of the very simplest nature When development is completed, the print is put into cold water, which chills the gelatine and stops any further solution The prints may now be regarded as fixed, but it is better to harden the film and to remove the slight stain of bichromate by clearing it in an alum bath One ounce of alum is dissolved in a pint of water The print is left in the alum bath until free from the least trace of yellow tinge, five minutes to half an hour will be required for this, according to the thickness and texture of the paper support Should there be any turbidity of the alum solution, a few drops of sulphuric acid will clear it The final step is to wash the print in water, five minutes or more, and hang it up by wooden clips to dry

Carbon printing on inflexible and other special supports is to be dealt with in a later chapter In the meantime it may be mentioned that opal pictures are produced in exactly the same manner as above described, the opal glass taking the place of single transfer paper, and the ground surface of the opal being used to squeegee upon Indeed, printing by single transfer on the fine matt opal which is so much admired is in several ways actually the

simplest and easiest form of the carbon process It is a method that can with confidence be recommended to the beginner, the only reason why we have described printing on paper in the first instance being that, of course, this must always be the form most largely used

CHAPTER VII

The Double Transfer Process

If printing in carbon is practised to any considerable extent, cases will often be met with where it is desirable or necessary to employ the "double transfer" method, so that by a second time transferring, and in effect turning over the image-bearing film, the right and left-hand sides may be brought into their proper relationship, giving a strictly faithful picture of the objects photographed Again, when such a material as ivory is to be made the basis of the picture, there is reason, as will appear in due course, for giving preference to the double transfer process We shall confine our attention at present to that form of the process in which paper or cardboard is employed as the final support

Development must be performed while the pigmented gelatine film is mounted on a "temporary support," which may either be flexible or rigid For example, the specially-prepared flexible paper, a sheet of celluloid, smooth or matt, a plate of glass, ground-glass, mulled zinc, or "smoothed opal" may be used, the first-named for

preference In any case, as the support has to fulfil a purely temporary purpose, it must be such as to leave the picture readily after development, and so its surface must be glazed with a very thin stratum (a mere soap-bubble film) of wax

The ready-prepared waxing solution, obtainable in bottles ready for use, can be recommended for this purpose, or one may be made at home, if preferred Melt a quarter of an ounce of yellow resin, stirring for a little time, remove it from the fire, and in a room where there is no artificial light to inflame the mixture add one pint of turpentine or benzole to dissolve it If an exceptionally quick-drying solution is wanted, the waxing compound can be dissolved in ether instead of turpentine Great care must be exercised to work by daylight on account of the highly inflammable nature of the vapour of ether, and its tendency to creep or flow over the surface of the table, so that combustion is caused by a naked light even some considerable distance away Again, to save the trouble of melting and mixing, "waxing compound" may be purchased in the form of cakes

Waxing the temporary support is a very simple operation, and is performed thus A small pool (consisting of a few drops only) of waxing solution is poured on the centre of the support and smeared over it so as to cover every part by the aid of a

pad of washleather, lint, or soft linen, or cotton flannel Next the surface is polished with a fresh piece of flannel, and set aside to dry In the polishing process care must be exercised not to clean off the whole of the wax at any point, as the effect of this will be apt to prove fatal when the time comes for stripping off the finished picture A good plan is to allow a few minutes to elapse prior to the polishing operation Thus all of the flexible supports that it is intended to use may be smeared with waxing solution consecutively, and then polished, going back to the first sheet and applying the polishing flannel to each sheet in succession in the same order The polishing should be done with a light circular motion, taking care to avoid streaks After stripping the picture from the temporary support, any wax adherent to the latter may be cleaned off with a flannel moistened with turpentine, but this is not necessary unless for the removal of dust etc, prior to rewaxing Before use, freshly-prepared temporary support should be set aside for some hours, so that the solvent may evaporate and the wax become quite hard

We will suppose that in the first place prepared flexible paper is used for the temporary support Such paper, rendered impervious with shellac and insoluble gelatine, is undoubtedly one of those things

that the carbon worker can buy from his material dealer more advantageously than he can prepare it for himself The same piece of support can be used over and over again for different prints, simply rewaxing after each transfer has been made, so that it is comparatively inexpensive The temporary support, which must be a little larger than the print intended to be placed on it, is immersed in cold water with the printed tissue, and the two are brought out together and squeegeed in close contact, exactly as was described in connection with the single transfer process Development and fixing are proceeded with in the same way also

Up to this point the operations are exactly as described in Chapter VI The image is perfect, the picture completed in every way, excepting that, having been printed from an ordinary negative, it is reversed as regards left and right. To complete the operation of double transfer, it has to be turned upside down, as it were, attaching it to a new and final support, and stripping off the waxed paper, when, of course, the positions of every part of the picture will assume their proper relationship to each other A carbon image exhibits a certain amount of relief, and so in this second transfer we must provide a bed of gelatine, in which the irregularity of the image-bearing film may bury itself

With this object, the paper which is to form the final support or mount is coated with gelatine that is toughened up to a certain point Its preparation is not an easy task, and in the great majority of cases the commercial "final support" that has been coated by machinery is very much to be preferred

For the preparation of any particular kind of paper not to be obtained commercially, the following may be relied on Let two ounces of photographic gelatine soak in sixteen ounces of water for half an hour, then apply a gentle heat to dissolve it Add, stirring well, a solution of five grains of chrome alum in one ounce of water This chrome gelatine solution is to be applied to the paper while warm, and two coats should be given After the first coat, the paper must be hung up to dry, and the drying should be fairly rapid and thorough Just previous to using it, the paper may be given a second coat of chrome gelatine, and, while this is wet, the picture may be placed down upon it and set aside to dry

If, as is to be preferred nine times out of ten, the ready-made final support is to be used, the following is the method of procedure A piece of the prepared paper is taken a little larger than the picture required, so as to allow for trimming, immersed in cold water, and, after a few

minutes' soaking, is put, together with the print intended to be transferred to it, into a dish of warm water, about 70° Fahr After a few seconds or so, as soon as the surface of the final support feels soft, the gelatine faces of the support and the print are brought together, squeegeed lightly but firmly, and hung up to dry The prints must be allowed to get "bone dry" When they are in this condition it will be found easy to separate the temporary from the final support by inserting the point of a penknife between them Assuming that the waxing process has been properly performed and the final transfer paper used in good condition and sufficiently soaked, the temporary support will come away readily

With old and "stale" gelatined paper, however, there may be a difficulty in rendering the gelatinous couch or bed soft enough and adhesive enough to answer its purpose In this case, a few minutes' soaking in quite hot water may suffice to render the gelatine spongy and serviceable, but if such treatment is carried too far the gelatine is apt to be washed off in places, with the result that at such places, deprived of their adhesiveness, bits of the picture film will be torn away on stripping off the temporary support The same thing is liable to happen, too, if the waxing of the temporary support should have been done imperfectly

Prints developed on a temporary support may be laid down and squeegeed upon their final support immediately, but it is preferable to allow them to dry first, and to immerse them in tepid water just prior to the final transfer, as has been described If, after drying, the finally transferred print, stripped from its temporary support, shows any wax adhering to its surface, this can be removed by rubbing gently with a tuft of cotton-wool dipped in alcohol

As the surface of the image has a finish exactly corresponding to that of the temporary support, it follows that by using a matt opal or grained zinc plate instead of the smooth flexible support an artistic dull surface is to be obtained The opal or other depolished plate used as a support will require waxing in just the same way as the smooth flexible support, and all the other operations must be carried out in the same way, with those slight variations obviously depending on the fact that a rigid in place of a flexible temporary support is employed It may be mentioned that the finely-ground opal plates should not have their coating of wax removed after they have once been treated with the solution It is only necessary to apply a little fresh solution in the ordinary way after each transfer has been made, and if by chance a print is spoiled in the process of development, it is better to waste a

piece of final support in transferring it rather than to scrub it off the prepared opal in hot water

Should a highly-glazed surface be desired, a piece of well-polished glass may be used in the temporary support It should be cleaned with caustic soda, washed and dried, dusted with French chalk by striking it lightly with a small flannel bag containing that material, waxed in the manner already described, and then coated with transfer collodion. A pool of the collodion is poured on, allowed to flow to the corners so as to cover the whole of the plate, and the excess drained off The plate is then held in a horizontal position until the collodion has set, when it is washed in water for a few minutes, until by the abstraction of the solvents all "greasiness" has been removed

CHAPTER VIII.

Faults—Their Causes and Cures.

It has been stated before that, as the mechanical nature of carbon printing stands in such sharp contrast with the chemical operations involved in other branches of photographic printing, so the difficulties that are apt to be met with in carbon printing are, if only the most ordinary care is used, easily avoided. Beginners may by lack of practice or from inattention to the simple directions given, meet with perfectly avoidable troubles, but few can be attributed to anything but the want of the exercise of reasonable care. Those which are most likely to be met with are given in the following list. The remedy will be obvious in most cases, except where specified, namely, simply to follow carefully the instructions we have laid down elsewhere:

If the tissue dissolves in the sensitising solution, the bath is too warm.

If the sensitised film runs while drying, the drying room or box is too warm.

If sparkling crystals appear in the tissue on drying, the sensitising bath is too strong.

If the tissue exhibits countless little cracks, the sensitising bath was too strong or too warm, or the tissue was immersed too long

If the tissue sticks to the negative, the negative, printing pad, or tissue was damp Each should be quite dry

If the tissue is insoluble, it has been sensitised in an acid bichromate bath A little ammonia may be added to the solution Or the tissue has been dried too slowly, or exposed to impure air, or to white light, while drying, or has been kept too long after sensitising, or kept too long in a damp atmosphere between exposure and development The quickest way to ascertain whether a sheet of sensitised tissue is good or not is to immerse a small piece of it in warm water If the gelatine dissolves, the tissue may be considered to be good Sensitised tissue may often be kept good for months if stored in calcium tubes, in the same way as platinotype paper is preserved

If the tissue frills upon development, no safe-edge has been used, or it is inefficient Or the tissue has been allowed to soak too long in cold water before squeegeeing it to its temporary support. Or too short a time has been allowed between squeegeeing to the support and developing

If the tissue "reticulates"—that is to say, if there is an apparently regular net-

work of minute bubbles all over its surface—the bichromate bath has been too strong, or it has been over-printed and over-developed in water at too high a temperature

If the edges wash up in development, the tissue has become insoluble, or it has been immersed over long in water before mounting, or the safe-edge was placed on the film side instead of on the glass side of the negative, or was otherwise inefficient

If the print wrinkles or creases during development, development has been too much hurried

If there is a loss of half-tone, the bichromate bath was too weak, or the tissue was used too soon after sensitising, or development was commenced with water that was too hot, or the tissue was under-exposed

If there is a loss of detail in high lights, the negative was too hard The tissue in such a case should be exposed to light for one or two seconds before development

If the picture is too dark, it is due to insolubility of the tissue or to over-exposure Very hot water may be tried, or a dilute solution of chloride of lime used with which to develop

If the picture is too light, the bichromate bath was too weak, or the tissue too new Or the print was under-exposed and may be intensified If under-exposure is suspected, the print should be kept in a damp

atmosphere for some time before development, and developed with cool water

If the print is stained locally, there have been air bubbles in the sensitising bath or in the developing bath, or the prints have been allowed to come into contact with one another during development

If there are net-like cracks in the finished print, they indicate too rapid drying after transfer

If there is difficulty in stripping the final support from the print in double transfer, the waxing has been imperfect, or the wax film has been polished off too closely

If the print when drying springs from the rigid support, too much wax was put on the plate, or the wax was adulterated with tallow, or the print was dried at too high a temperature

If the transfer paper comes away without the picture, the transfer paper was dipped in too hot water, or the print was left too long in the alum bath

If there are bright specks in the high lights and margins of the print, the water for softening the transfer paper was not hot enough

If there are shining lines against deep shadows, the final support was not soaked sufficiently in hot water

If there is a sparkling appearance in the finished print, there may have been too little pressure during the final transfer

CHAPTER IX

Modifications of the Carbon Process—Opals—Gravure Printing

Having described the manipulations of the ordinary carbon process in detail, we will deal now with the transfer of such prints to a surface of opal, wood, glass, or other rigid material

The only peculiarity lies in a special preparation of the support for the reception of the image, and even this additional operation is not necessary in all cases The toughened gelatine which constitutes the image of a carbon print has lost the stickiness that is characteristic of unaltered gelatine, and in the single transfer process we have to cause a flat surface, and with the double transfer a very slightly uneven surface of this leathery substance, to adhere to the material of the permanent support The obvious indication is to employ a substratum of soft, adhesive gelatine, and evidently a thicker one will be called for in the double than in the single transfer method

There is also this difference between the requirements of single and double transfer, so far as regards the bedding or cementing of the image to its final support In the one case, after the smooth surface of toughened gelatine has been laid down on its rigid support, the backing of tissue is brought away without the exercise of any appreciable force, because of the solution in warm water of its gelatinous attachment In the other case, after squeegeeing the uneven face of the print on to its support and drying the whole, quite a strain is brought to bear upon the newly-formed attachment by the process of stripping off the waxed temporary support

If we are working single transfer it is only necessary to omit the waxing of the opal support used as described in Chapter VI, and we obtain a "porcelain portrait" in the very simplest way possible Let the opal be well cleaned with French chalk and the print squeegeed down on it and developed in the ordinary manner After being alumed and dried, the picture will be found to possess an exquisite and distinctive softness and delicacy, and will admit of a great range of artistic treatment either in monochrome or colour

For greater security in making single transfer prints on opal, it is a good plan to use a substratum, the plate being in the first place thoroughly cleaned and freed

from grease, of course. An easily-made substratum, to be applied a few hours before the plate is required for use, consists of the whites of three eggs beaten to a froth with the addition of one ounce of water and five or six drops of liquor ammonia. A coating of this solution having been applied, the plate is dried in a dust-free atmosphere. This will do equally well for single transfer prints of clear glass, opal, or other rigid surfaces.

Carbon prints developed on a flexible support can be transferred to smooth glass, polished metal, wood, leather, or a dozen other such materials, provided that we apply a coating of insoluble gelatine to prepare the surface of the material in question. Scores of recipes—most of them workable—for preparing substrata have been given in the different manuals. The following will be found to be as good as any.

Put one ounce of gelatine in a pint of distilled water. After soaking four hours dissolve by the aid of heat, as by immersing the jar in a saucepan of hot water. Then dissolve twenty grains of chrome alum in two ounces of water, and add this by a few drops at a time to the solution of gelatine, while stirring vigorously. If the stirring is insufficient, or if the chrome alum is too quickly added, gelatine will be precipitated. The print may be lightly squeegeed down while the substratum is still soft.

Another standard recipe, though not to be preferred to the preceding, is to dissolve one ounce of gelatine in a pint jar of water, after two ounces of water have been withdrawn from the amount required to fill it. In the smaller quantity of water are to be dissolved twenty grains of potassium bichromate, and this is to be added slowly, with stirring, to the eighteen ounces of gelatine solution. Having been thinly and evenly coated on the support, this substratum is to be allowed to dry in broad daylight, so as to be rendered quite insoluble by the action of light. Of course, it must be soaked in water before the application of the print.

An elegant form of substratum is the alcoholic solution, for which the following recipe was given by the late Mr. William Bedford: Soak and ultimately dissolve by heat 270 grains of hard gelatine in three and a half ounces of water. To this add enough of a five per cent. chrome alum solution thoroughly to precipitate the gelatine, which is then to be collected and the water allowed to drain off. Finally the precipitated gelatine is dissolved in seven drams of glacial acetic acid over a water bath, diluted by the gradual addition of seventeen ounces of methylated spirit, and filtered for use.

It need hardly be stated that in making prints by double transfer upon any rigid

surface, it is necessary to make use of flexible and not rigid temporary supports. To make a transfer from one rigid surface to another would be impracticable.

Carbon prints on boxwood are said to afford a good foundation for the work of the wood engraver, and for this purpose—as the wood engraver needs a reversed print—of course the single transfer process with ordinary negatives is used.

Carbon prints on ivory as a basis for miniature painting must always be made by double transfer, as if potassium bichromate is brought into contact with ivory it leaves a stain that is difficult to remove. The substratum of chrome alum and gelatine should be employed. The picture, printed, developed, and cleared on a piece of flexible support, may be brought into contact with the clean, polished ivory surface while immersed in such a chrome gelatine solution, then lightly squeegeed and dried, when the waxed temporary support will readily come away. Transfers to leather, painters' canvas, and other fabrics can be made upon the same foundation of chrome gelatine. For porous wood, a preliminary coating of Aspinall's enamel, thinned with turpentine and rubbed in with a pad, is recommended.

A very interesting modification of the carbon process, which was described in *Photography* some time ago, permits of

the use of the single transfer process with ordinary negatives, and affords an exceptional protection against damp and dust In fact, should the prints made by this method become dirty, they can be sponged down or even washed with soap and water without risk of injury A thin sheet of clear, transparent celluloid, washed with soap and water and well rinsed, is coated with a slightly warm solution of gelatine and bichromate (A quarter of an ounce of Heinrich's gelatine dissolved in half a pint of water, fifty grains of potassium bichromate dissolved in another half-pint of water, the two solutions mixed and filtered through a double thickness of swans' down calico) The celluloid sheet having been coated with this solution, as much of it as possible is poured off again, and the sheet dried and exposed to light for some hours The transfer and development of the print are then conducted just as usual, except that the use of unduly hot water must be avoided, owing to its softening action upon celluloid After the print has been alumed, washed, and dried, nothing remains but to back it up with a suitable white or toned paper This is by no means a difficult variant of carbon printing, and in certain classes of work it yields exceptionally fine results

Gravure Printing —This is a modification of the carbon process for obtaining

prints which give the effect of photogravure, having a matt surface and retaining the grain of the paper. For this purpose, special "gravure" tissue and supports are wanted. These are manufactured at present in three tints—special X (resembling sepia photogravures), red chalk, and carbon sepia. The process can be used by either the double or the single transfer process, preserving all the qualities of surface of the paper to which it is transferred. The gravure tissue is printed and developed in the same way as ordinary carbon tissue with but few exceptions. It is twice as sensitive as the ordinary tissue, and over-printing must be carefully avoided. The special temporary support is to be waxed evenly by a gentle rubbing, and not polished. After mounting for development, the print and support are to be left between blotting-boards or paper for from ten to fifteen minutes; and after the usual routine of developing and fixing the print is to be allowed to become almost dry before transfer to the final support.

When a quantity of gravure prints are to be mounted at one time on card, they can be wetted just the same as silver prints. To mount on vellum or parchment, however, only about a quarter-inch of the margin of the print is to be coated with seccotine, Higgins's mountant, or some other containing a minimum amount of moisture, and

the mounted print is to be placed immediately under a heavy weight, where it should remain two or three hours at least

CHAPTER X.

TRANSPARENCIES AND LANTERN SLIDES.

The transfer of carbon images to solid and opaque supports was described in the previous chapter, and it may be inferred that the methods mentioned there could be employed in making transparencies or lantern slides. The roughened or matt surfaces generally preferred on opals, etc., favour the adhesion of the film; and, while transparencies are sometimes transferred on to a finely-ground surface of glass, the ordinary polished surface of glass is used more commonly—invariably for lantern slides. The single transfer process is always used in the making of transparencies, as these can be viewed from either side indifferently, so that no difficulty arises from reversal.

It is not absolutely necessary to apply any kind of substratum to the polished glass surface to which a transparency is to be permanently applied. The only preparation—beyond, of course, thoroughly cleaning the glass, as is necessary in any case—is to immerse the exposed tissue in a very dilute solution of hydrochloric acid, formed

by adding, say, sixteen drops of the acid to each quart of water used The glass is then brought underneath the saturated tissue, which is squeegeed down upon it in the ordinary way and development proceeded with as usual A substratum is to be recommended, however

Either one of the substrata previously mentioned can be used The exact composition is not of importance Perhaps the best is that compounded of gelatine and chrome alum, but there is none easier to make and use than the following Soak threequarters of an ounce of photographic gelatine in a pint of water, dissolve by the application of gentle heat, and add sufficient bichromate solution to impart a golden sherry colour The solution is at once filtered through cotton-wool and used while warm, the glass plates being both coated and dried in daylight Indeed, they are the better if coated some days before use, so as to ensure complete insolubility of the gelatine

Among the various preparations which have been recommended for lantern slide transfers is Bedford's substratum, described in the last chapter Again, water-glass solution (sodium silicate in the proportion of one dram to three ounces of water) may be applied to the glass plate like collodion, and allowed to dry thoroughly before the application of the pigment print, as water-

glass, after it has once dried h
difficulty redissolved. Or, if a t
of albumen is used—the white
well beaten up into one pint
which fifteen drops of ammonia
the glass plates can be simply i
this and drained and stood up i
dry. Whichever plan is used, if
and dried glass plates are inter
sheets of tissue paper, they ca
away until required for use; an
found that a large number can l
thus in a short time and wit
trouble.

There is hardly any need to
instructions for cleaning the gl
mounting transparencies. Im
caustic soda solution can be res
the removal of obstinate dirt.
the binding of a slide or transp
for any explanation, since it is
application of a paper edging to
the glass a second plate of the
for the protection of the ima
familiar to all lanternists. In t
stereoscopic slides and win
parencies, this protective covering
be finely ground so as to soften
the transmitted light; or a mati
varnish may be given to it i
separate cloud negative may be
the cover-glass if desired, and
face to face with the landscape

affording an opportunity of modifying the cloud effect experimentally

There is one point we have not mentioned which is of the greatest importance for pictures intended to be viewed by transmitted light This is that such pictures must be printed much darker than those intended to be mounted on paper and viewed by reflected light. For transparency making, therefore, we should use a dark-coloured carbon tissue, preferably one which has been kept five or six days after sensitising, and should print deeply from a vigorous negative All this, however, may not suffice to give strength enough to the image for projection by a powerful lantern, therefore lantern slides, carbon negatives, and indeed all transparencies, are much better and more conveniently made on the tissue specially manufactured for that purpose It contains a larger proportion than ordinary tissue of very finely-ground pigment

This transparency tissue is used in exactly the same way as the ordinary make, the only difference being that an exposure for about as long again in the printing frame is required It is unsurpassed as a medium for the production of window decorations and lantern slides (When making the latter, an ordinary lantern slide mask may be conveniently used to form the safe-edge) And in positive transparencies

intended for the production of enlarged negatives, this carbon tissue gives a richness and brilliancy not to be attained by any other means.

Of course, transparencies on glass can be backed with opaque paper, as with the prints on celluloid described in the previous chapter. In such a case, as the image is viewed by reflected light, it becomes a transparency only in name, and may be printed in any of the ordinary tissues. Very fine effects are to be obtained by varying the tones of image and backing.

CHAPTER XI

CLOUDS AND BACKGROUNDS—ING — SPOTTING — COLOUR-ONING AND INTENSIFYING — AND MOUNTING

n *Clouds* —Notwithstanding the carbon printer has to dark," to some extent, when e same piece of paper from in succession, he need not ifficulty in obtaining cloud nbination printing with the cy of register There are hat can be adopted One is plan with other printing pro-d to the carbon process, id is peculiar to it, and much d better

, we may say that if many be made, it will be worth fice a piece of printing-out luce the necessary mask n the P O P, and then, while int down upon a flat surface itive, run a trimming knife l the edge Next with a cissors, cut as nearly as pos-

sible along the horizon line of the silver print, and expose both pieces—the sky portion and the foreground portion—to light until they are uniformly browned Having selected the cloud negative, put the landscape negative upon it, so that the cloud effects appear in the position wished for, and with a piece of crayon that can be afterwards easily rubbed off mark round the edges of the landscape negative so as to indicate its exact position on the other Now, touching the sky mask with any adhesive, fix it in position on the back of the landscape negative, trim a piece of sensitive carbon tissue to the exact size of the negative, and, adjusting it symmetrically, proceed to print in the ordinary way The next step is to place the landscape mask on the front of the cloud negative, the outline tracing of the landscape negative being taken as a guide to its position This same guide, of course, serves for registration of the printed tissue on the cloud negative, and during the exposure that follows (which must be very short) a piece of card should be moved from the top to the bottom of the clouds in the negative, and then moved up and down over the junction, the object of this treatment being to soften the skyline and render the clouds lighter near the horizon Alternatively, the masks may be made by taking a tracing of the horizon line with a pencil on thin white paper,

holding the negative up to the light, an impression of this tracing is then marked through on to a piece of yellow or opaque paper by means of a blunt-ended scriber, when the cutting out is proceeded with as before And again, the tissue to be printed need have only one of its angles cut to a right angle, this angle and one straight-cut side being placed in register with one angle and side of the negative during printing If, then, the landscape mask is stuck on the glass side of the cloud negative in its intended place, while a chalk outline is drawn to show the position of the register side and corner of the landscape negative, it is evident that the trimmed parts of the tissue may be set to this outline, thus effecting the object that we have in view

The second plan is one which was recently described in a leading article in *Photography* The landscape print is made and developed in the ordinary way, and allowed to dry thoroughly and harden The cloud negative should then be fitted in a suitable frame, the landscape print may be placed behind it, the level of the horizon marked, and masks adjusted It is well, in addition, to vignette slightly the lower edge, so that no hard line shall be found A print is now to be made upon a sheet of tissue for the clouds, the exposure should be distinctly on the side of under-exposure The line of the horizon is marked on the

back of the tissue, which is then squeegeed on the top of the finished landscape print It is desirable that the lower edge of the tissue, where the print overlaps the landscape, should be trimmed at the last moment, as the action of the air and moisture on the exposed edge has a tendency to harden it, and a line might be found difficult to remove by development Development should take place at first with tepid water only, as the lightly-printed image is easily dissolved

When the general tone of the sky has been reached, the clouds overlapping upon the landscape—if such overlapping has taken place, notwithstanding all care in vignetting—can be removed in one of two ways

While the print lies in tepid water, a camel-hair mop may be used As soon as the brush enters the water, the hairs will spread out, and by bringing it gently in contact with the parts to be softened they are easily removed

A better way, and one by which the tint overlapping masses of trees or buildings may be removed, is to make up a wash bottle with a tin can Both tubes should be fitted with indiarubber tubes, that which is to be blown into may terminate with a fairly wide glass pipe, which can be gripped tightly between the lips The other tube should end in a short length of

glass tube brought to a fine point The tin wash bottle can be filled with hot water, and may be stood conveniently over a spirit lamp or Bunsen burner The print is then laid upon the usual zinc or ebonite plate, and the stream of hot water directed forcibly upon it The distance of the print from the nozzle of the pipe will enable the water to be discharged either in broad fine spray or in a thin stream When the printing has been correctly performed, the spray need not be very hot If over-exposure has taken place, necessitating the use of hotter water, it will be desirable to cork up lightly the aperture for the mouth tube, and allow the water to be driven from the delivery tube by the force of the generating steam

Printing in Backgrounds—Combination printing, introducing different figures or supplying a new background to a portrait, can be done in the manner indicated below Having made an untoned and unfixed silver print, cut out the figure with the point of a sharp penknife, and let the cut-out or background mask and also the figure mask be browned by light Stick the background mask on to the negative, so that the outline of the cut-out mask agrees with that of the figure Then dab a little *thick* indiarubber solution on the upper edge of the mask, put the carbon tissue down on it, and, after the rubber cement has set, insert it in the printing frame

After the figure has been printed in thus, raise the free end of the sensitive tissue, put the figure mask into its place, and smear it on the back (that side next the sensitive tissue) with rubber solution, put down the tissue as before, and, after allowing two or three minutes for hardening of the cement, raise the tissue and pull it away from its temporary attachment at the upper edge of the background mask With a soft dry cloth rub off any adhering cement from the imprinted part of the tissue, and proceed to print in the new background Finally, tear off the figure mask, using the dry cloth as before, if necessary, and develop as usual

RETOUCHING, SPOTTING, AND COLOURING

Parts of the carbon print which are too dark can be lightened by rubbing with finely-powdered pumicestone, as also by the careful use of an erasing knife If such retouching is done before final transfer, it will be less easily detected, of course, in the finished print Broad shadows can be deepened by rubbing in a mixture of fine lampblack or other appropriate colours in powdered form by means of a stump But such retouching and spotting out may be best done with a little of the actual pigment and gelatine composing the image

Cut a piece of unexposed tissue the size of a postage stamp, and soak it in cold water for half an hour Fill a porcelain

dish with boiling water, and place in it a quarter of a pound weight till both are thoroughly heated Empty the dish and refill it with the hot water not quite up to the upper surface of the weight Place the soaked bit of tissue film upwards on the weight, when the heat will melt the film This can now be used with a fine camel-hair brush, moistened in the hot water in the dish, with which also the colour can be diluted as required Having this method in view, one should make it a practice to preserve trimmings when cutting up the unsensitised tissue, and to pencil their colours on the back

A more convenient plan to many will be to purchase the spotting colours, which are supplied in sixpenny pans by makers of the tissue, since the identical pigments employed in the manufacture of commercial tissue are used in their preparation, so one is certain that the colour will match

To work up a carbon photograph in ordinary oil colours, one should apply a preliminary size consisting of 180 grains of isinglass dissolved in half a pint of water, to which is afterwards added, with constant stirring, an equal volume of methylated spirit Naturally, transparent colours will be used for the most part, and the whole can be varnished eventually to increase the brilliance of the picture If it is preferred to use water colours, the print should be

freed from any trace of wax by means of a flannel moistened with benzine, and a preparatory wash with prepared oxgall dissolved in dilute alcohol will be required Again, with prints transferred to grained paper, chalk tinting gives a very artistic effect

Toning and Intensifying

It is the great virtue of the carbon process of printing that, if reliable commercially-prepared tissues are employed, we have the knowledge that only pigment of an absolutely permanent type is used in building up the image Therefore the wisdom of strengthening or modifying the tone of this image by the addition of other colouring matter of perhaps less stability ought to be very seriously questioned None the less, chemical toning and intensifying are quite frequently resorted to by some carbon workers, and we must not omit mention of some of the methods which they employ

A tone that is in evidence all over the picture excepting in the deep shadows is given by transferring the carbon print to a support of tinted paper And here, again, while considerable risk is involved in this haphazard selection of material, there need be no difficulty in obtaining papers which can be relied upon to keep their colour well The effect to be aimed at thus is, strictly speaking, a dichromatic or bi-coloured one, and when the colour of the

paper for the lights and the tissue for the shadows of the picture is appropriately chosen, the result is very fine

By dyeing the print while it rests on a glass or opal temporary support, or by chemically precipitating coloured matter within its gelatinous body, the tone of the image proper can be changed or strengthened Among the dyestuffs not requiring a mordant are artificial alizarine, which yields a fine purple, and many other aniline dyes, which, however, are apt to prove very much otherwise than permanent Indeed, some of these dyes, as methylene blue and eosin, are so fleeting that they have been actually used to render a photographic image by the bleaching action of strong light

More permanent dyeing can be done by immersing the print in a solution of potassium permanganate of a strength proportioned to the degree of intensification desired The greenish colour produced is not, indeed, very agreeable to the eye, but has considerable photographic value, and the method, therefore, is useful in dealing with weak carbon negatives

A carbon print can be given a dark violet or purple black colour by the following treatment The print is steeped for five minutes in a four per cent solution of iron persulphate (not protosulphate), rinsed for an instant only in cold water, soaked for

two minutes in a two per cent solution of sodium carbonate, again rinsed for a moment, and then immersed in a one per cent gallic acid solution, until the desired colour has been reached Then it is washed and dried

A dark blue-black tint is obtained by the following procedure Logwood chips are extracted with hot water, which is allowed to become cold, and is then poured on to the damp print After a short time, the print is rinsed and immersed in potassium bichromate solution The process may be repeated several times, to strengthen the tone Care must be exercised, in using this and the other double decomposition methods of toning, to rinse off the surface after each solution has been applied If this is not done, a superficial deposit may be formed which is difficult of removal

A good black intensification can be had by soaking the picture in a solution of silver nitrate, two grains to the ounce After rinsing, it is flooded with pyrogallic acid one grain, citric acid one grain, water one ounce, to which are added at the moment of using two or three drops of a twenty per cent solution of silver nitrate After intensifying in this way, the prints should be dipped in a hyposulphite fixing bath, and be well washed

Since it will be evident that each of these processes intensifies the carbon

image, if a toning effect alone is aimed at the printing of this tissue should not be carried so far as usual None of these methods are to be recommended, nor are they frequently resorted to They are mainly of service when vigorous carbon transparencies or negatives from thin originals are being made for use in enlarging

TRIMMING AND MOUNTING

The trimming of carbon prints is preferably done with the aid of a glass shape and by means of a sharp, long-bladed pair of scissors—the kind used by paperhangers Many of the ordinary cutting knives are apt to pull or jag the edge of the tissue In the mounting of single transfer prints, no special precautions are required, in fact, a large number of such prints, after trimming, can be wetted and laid one on another in a pile, to be starched or gummed or gelatined on the back, and mounted in the same way as silver prints Double transfer prints, having a very delicate surface, should be mounted separately

While any of the ordinary preparations may be used, of course those mountants containing spirit have the advantage that they are less apt to produce cockling of the mount Friction on the surface of the print while damp is to be avoided Many prefer mounting while the prints are quite dry with a rubber cement, or Le Page's

glue, and this is an especially good plan in the case of large prints upon thick paper, such prints must be induced to stick fast by a somewhat prolonged application of pressure It is worth noting here that the objections taken to common starch as a mountant for silver prints have no weight in the case of carbon, owing to the indestructibility of the pigments (Such starch may be made more adhesive by dissolving with it ten per cent of sugar)

In many instances it will be found that the mounting of a carbon print can be dispensed with to advantage By blocking out all parts of the negative except those intended to show in the picture, and then transferring and developing the print on a larger piece of transfer paper, a proof having much the appearance of an engraving is produced Owing to the broad margin, we have here mount and picture combined With toned transfer papers, some beautiful combinations of tint are to be made in this way, in planning which, however, we must remember that the dark background indicates the desirability of a little under-printing of the tissue Once more, it will be evident that if we employ an extra large printing frame, we can use masks either for ordinary vignetting or to produce a broad unexposed margin of tissue round the print, that can be afterwards sunned down to give a border of

such depth as is desired in the same colour as the image itself

A finished carbon print, after warming to remove any trace of moisture, may be burnished in an ordinary rolling press; or it may be coated with shellac, crystal, or wax varnish The highest glaze, however, is obtained by transferring the print from a waxed glass plate that has been coated with transfer collodion Such glossy prints, of course, are out of fashion

CHAPTER XII

Ozotype—Mariotype

An interesting method of pigment printing, involving a radical departure from the principles of the ordinary carbon process, has been invented by Mr Thos Manly, and named by him ozotype The necessary procedure and formulæ have been made the subject of a patent, and the materials are commercially obtainable The following details will give an idea of the process in outline

For the permanent support on which the pigment print is to be applied, ordinary single transfer paper is taken, and this is sensitised by immersion in a solution of fourteen parts manganous sulphate and seven parts of potassium bichromate in one hundred parts of water Or the sensitising may be performed by pinning down the sheet of transfer paper on a drawing-board or other flat surface, pouring a small pool of solution on the centre, and spreading it quickly over the whole surface of the paper with a brush A quarter of an ounce of sensitising solution used in this way should suffice for a sheet of paper measur-

ing 25in × 20in, if the operation is expeditiously performed before any liquid has had time to soak through the paper Or, instead of the transfer paper, any ordinary paper may be used, if it is appropriately sized A ten per cent solution of Le Page's fish-glue makes a good size, it is applied with a 3in camel-hair brush, or, if the paper is at all rough, with a flat hog-hair varnish brush The sized paper may be completely dried, and must, at any rate, be nearly dry before sensitising

The choice of paper—which is to form the final support of the print, it will be remembered—is practically unlimited Collotype printing paper and ordinary drawing-paper have been recommended, but the commercially-prepared transfer paper has the advantage on account of the certainty with which the pigmented gelatine film that is to form the picture sticks to it If common rough drawing-paper is used, it should be thinly coated, after the printing-out process, with a two per cent solution of gelatine This coating should be given after the manganic print—exposed rather more fully than usual—has been washed and dried, and it should be so thin that only the deep shadows show any gloss

The printing of the sensitised paper is done in an ordinary hinged frame, just as with silver P O P A light brown image is obtained, and when the details in the high

lights are distinct the operation will have been carried far enough The brown image evidences a chemical reaction between the bichromate and the manganous salt used in sensitising, the result being that the latter substance is converted into an insoluble manganic compound which is capable of oxidising gelatine and rendering it insoluble

The next stage is to wash out from the paper all soluble salts, having nothing but the image in manganic oxide. This need not be done immediately The washing may be deferred until a day's printing has been completed About three changes of water will generally be found sufficient, the completion of the operation being shown when the washing water is colourless Next a piece of ordinary carbon tissue, which is to build up the image proper, has to be squeegeed on to our paper support

A solution is made of thirty minims acetic acid, seven grains hydroquinone, and five grains ferrous sulphate in twenty ounces of water The unsensitised carbon tissue, cut to size, is immersed in this bath and allowed to remain there for about a minute, the temperature of the solution being kept between 65° and 75° Fahr. The print is then plunged under the surface of the same solution, brought into contact with the gelatine surface of the unsensitised tissue, and the two are then drawn out,

clinging together, and are squeegeed down upon a flat surface They are then blotted off and hung up or laid away to dry After this drying is completed, it will be found that the gelatine has been rendered partly insoluble, the chemical action penetrating it to different depths, according to the intensity of the underlying manganic image Wherever a shade appears in the picture (and to an extent dependent on the depth of that shade), the film of pigmented gelatine will be rendered insoluble, and, on the other hand, over the whites of the picture the gelatine will remain unaltered Thus exactly the same effect will be produced as if the carbon tissue had been sensitised in the ordinary way and then printed from the back from a reversed negative

To develop, the dried print is put into cold water, where it remains for not more than half an hour It is then put into warm water of from 102° to 105° Fahr, and after an immersion of about a minute it will be found that the backing of the carbon tissue can be pulled off by the application of gentle force The backing of the tissue having been removed thus, while the print is immersed in the warm water, development proceeds on the same lines as in the ordinary carbon process The print is drawn up on a sheet of zinc or other such support and laved with warm water, it will be found that the gelatine is a little softer

—more amenable to local treatment with the brush, etc.—than in ordinary carbon printing. After development, the print is rinsed in cold water, and toughened in a bath of alum, threequarters of an ounce to the pint of water. The print is completed by drying, and the image, of course, is non-reversed.

The process is one which is itself undergoing development in the hands of its inventor, to whom we must refer our readers for further details. We have said enough, however, to show that it constitutes a radical departure from ordinary carbon methods.

Mariotype.

The nearest modification of the carbon process to ozotype, although still very different from it, is the almost forgotten Mariotype, as it was called after its inventor. In his communication to the Royal Photographic Society in 1873, he said that there were two methods, known respectively as "Mariotype by pressure" and "Mariotype by contact." We will give what follows in M. A. Marion's own words.

In Mariotype by pressure, said he, a simple vertical press is necessary, such as is employed for collographic or Woodbury-type printing. Only one single exposure under a negative is required, the image or printing block thus obtained serving to transmit the sensitive action to the pigment

paper, which gives rise to the picture and transfers it to the paper support

A Mariotype sheet (D) of gelatine, of a matt white colour, is sensitised on a four per cent solution of potassium bichromate, dried, and exposed under a negative for a suitable period, the image produced being a visible one This sheet is next put into another bichromate bath, half the strength of the former one, the result being the same as if it were dipped into cold water, those portions of the gelatine sheet which have not been acted upon by light swell up, while the solarised parts remain as hollows upon the surface, according to the degree to which the same has been acted upon

The gelatine sheet is taken from the bath, freed from an excess of moisture, and is now put into the press ready for printing from Instead of applying ink to the block as in the collographic process, an alum-bichromate solution is made, composed of

Water	100 parts
Chrome alum	2 ,,
Potassium bichromate	2 ,,

This is applied with a sponge, and the excess removed with blotting-paper A piece of pigment tissue is then put under the press, upon the printing block, impregnated as it is with alum-bichromate solution, and the two surfaces screwed together

Afterwards the pigment tissue is withdrawn from the press, and another piece

substituted, the printing block being first moistened again with a sponge full of alum-bichromate solution, and the excess removed by blotting-paper. In this way an unlimited number of copies may be produced, the pigment tissue becoming impressed, or solarised so to speak, in those parts corresponding to the design with which it has been placed in contact. All the operations must be carried on in a locality sheltered from glaring daylight; but when the invisible images upon the pigment tissue have been produced, they are placed for a few minutes where the light can act upon them. They are then ready for application to their support, coagulated albumenised paper.

The printed pigment tissue is plunged into cold water, together with the albumenised paper, and then withdrawn in contact, placed upon a glass, and rubbed with a squeegee. The development of the image is next undertaken by the aid of warm water of a temperature of from 40° to 50° C. The half-tones are admirably preserved, and the print, contrary to what happens in collographic printing, is produced in its true aspect, because, of course, the transmission of the image goes from one surface to the other, or, in other words, an impression and counter-impression are produced. In the daytime, a large number of prints may be thus produced by pres-

sure, exposed to daylight for the few minutes required, and the rest of the operations may then be pursued during the evening at leisure In about an hour, as many as fifty carbon prints may be obtained, equal and uniform in their nature, and this, too, by simply one exposure to light to obtain an image to serve as a printing-block, the pressure of a piece of pigment tissue in contact being sufficient to produce copies therefrom

Mariotype by contact is different in its nature It is well known that in the ordinary carbon process at least two descriptions of paper are employed—pigmented tissue and transfer paper A third is sometimes used for an intermediate transfer, or as a provisional support to the image

In producing pictures by Mariotype by contact, no transfer of the image is necessary, and yet the print is obtained in its true aspect Instead of sensitising or exposing the pigment tissue, I sensitise and expose the transfer paper The image is then produced in its proper aspect, just the same as in silver printing, but the image is of a pale brown tint, and without vigour The paper which I employ for transferring is of a very slightly gelatined nature (C), although I think it would be better to have it albumenised, waxed, and gelatined, and this is floated upon a six per cent solution of potassium bichromate,

to which a little sulphuric acid has been added, for about a minute.

When dry, the paper is exposed under a negative for a sufficient time, the image produced being visible and capable of examination from time to time by opening one of the covers of the printing frame. A piece of pigment paper of any desired tint is then put into a two per cent. bath of potassium bichromate, together with the printed transfer paper; and the two are withdrawn in contact, and scraped with the squeegee, to ensure perfect adhesion.

In this condition, the prints are allowed to remain pressed together between sheets of blotting-paper under a weight for a period of from eight to ten hours. Surfaces placed in contact in the evening may be developed next morning; and the more prints there are the more chance there is of success, for they must not become dry whilst in contact. And it is well, of course, that all the prints pressed at one time should be of the same dimensions.

Under this slight pressure, a continuation of the solarisation goes on by transmission; for when the pigmented tissue comes to be developed the picture appears fully printed, or toned if you like, and in its right aspect upon the transfer paper. The development of the prints is conducted in warm water (at from 40° to 50° C.)

The washing away of the gelatine and

pigment is aided by a fine brush, or, better still, by letting the print remain face downwards in the warm water for a period sufficient for its complete removal In this way, the half-tones are secured in their most perfect condition for there is neither transfer nor reversal of the image The development takes place from the face, and not from the back, of the image, as is the case in the transfer process, therefore, the half-tones remain adherent to the paper in all their integrity, exactly in the same way as in silver printing

Although the photometer is no longer an object of the first importance in this process, it is nevertheless very useful, because the image is very pale when seen upon the paper, and the limit of exposure is easily exceeded By using a photometer, the pose may be limited, of course, with the greatest nicety, for a preliminary essay will point out the degree upon the photometric scale to which the exposure to light should be pressed

CHAPTER XIII.

THE GUM-BICHROMATE AND ARTIGUE PROCESSES.

The gum-bichromate process, or carbon printing without transfer, is really one of the oldest of the photographic printing processes; but, at a time when definition in a photograph was more valued than it is by some artists of to-day, this method was quickly abandoned in favour of "transfer" carbon printing as now generally practised. The reason for the inferiority in detail of most carbon prints made without transfer has been shown in Chapter I. of this book. The fine detail and half-tones being represented by a thin insoluble film of the upper surface of the tissue, they break away and become lost in development, if not transferred first. But if that sensitive material be applied to paper in a thin solution of a more or less granular character, development by dissolving away underlying portions of the pigmented material is to some extent practicable.

For this purpose, it is best to use a more easily soluble vehicle than gelatine, such as gum. Gum, it will be understood, ex-

hibits the same kind of sensitiveness to light as does platine, when exposed in the presence of a bichromate Those parts protected from the light remain freely soluble, while those acted upon are toughened and resist solution We will now give one or two of the standard formulæ which may be used by those who wish to experiment with gum-bichromate

Dissolve four ounces of clean white gum arabic in six ounces of water, and, when solution is complete, strain the liquid through a piece of very fine muslin In a room illuminated by yellow light, mix this gum solution with an equal volume of a ten or twelve per cent solution of potassium bichromate, then stir in thoroughly a sufficient quantity of some ordinary water colour or colours to make a tint of about the depth of an artist's wash The degree of thinness required in the mixed colour is that which will allow of light penetrating freely into the substance of the treated paper The ground pigments commonly sold in small tubes or pans are convenient for this purpose, and among these colours, used singly or in combination, we have a very considerable range of choice Prussian blue, cobalt, sepia, the various earth colours, ivory black, and the madder lakes are among those which are suitable, while some few—as indigo and ultramarine blue—should be avoided

Paper is coated with this tinted and sensitive gum solution by means of a large and soft brush, or the solution can be applied by means of a badger-hair softener, worked well over the surface until it appears of a uniform tint when examined by transmitted light, or, again, a spraying apparatus can be used for the impregnation of the paper The paper used must not be too smooth, and, indeed, upon this depends success in the rendering of gradation It may with advantage be prepared by stretching, the paper being damped with a sponge on each side, and then gummed down upon a drawing-board, or one of the prepared pads of rough drawing-paper, sold for the purpose of sketching in water colours, may be employed. The drying of the coated paper is conducted just as has been described for drying freshly-sensitised tissue; and, like carbon tissue, the gum-bichromate paper undergoes a change on keeping which makes it insensitive, and therefore useless

Exposure—since it is required that the light shall be effective photographically to some depth within the gummed paper—must be somewhat prolonged, say to about double the length of time required in silver printing An actinometer should be used to gauge the exposure necessary, or the appearance of detail in the shadows of the faint image seen when examining the print

by transmitted light may be taken as a criterion

Development is effected by the same kind of manipulation as has been described in connection with carbon printing proper, except that it may be commenced with cold water, and that water so highly heated as is appropriate in treating gelatine tissue will seldom be required

M Demachy recommends, in place of the gum solution mentioned in the preceding formula, one of four ounces gum, one ounce citric acid, and fifteen ounces of water, to be mixed with bichromate solution of course, as previously described Pouncy, the inventor of the process, in his original description mentioned (A) saturated solution of potassium bichromate, (B) gum of the consistency of thin varnish, (C) vegetable carbon or other finely-ground pigment forming a thin emulsion in water Equal parts of A and B were to be mixed with about one-eighth of their total volume of C, laid on paper with a broad camel-hair brush—a copious supply being permitted to rest on the surface for a couple of minutes for absorption—and the superfluous liquid then removed by working regularly over the whole surface of the paper, with alternate vertical and horizontal motions, a painter's 4in hog-hair softener The result of this treatment is a smooth and even surface, which is to be dried as already directed

On removal from the printing frame, the picture is to be laid face downwards in a dish of clean water, carefully excluding air bubbles, and placing on the back of the print a light wooden stick, so as to keep it wholly submerged and prevent staining. The time of soaking for development may be from five minutes up to days even, and a final clearing may be given by means of a gentle stream of water from a tap or jug, aided, if necessary, by passing a camel-hair brush over certain parts of the image. A very prompt appearance of the high lights may indicate under-exposure, or it may be that the gum arabic was too thick—a fault which can be corrected by the addition of more potassium bichromate solution.

Yet another recipe for the coating of gum-bichromate paper is that of M. Ladavize. Four ounces of clean-picked gum arabic are dissolved in eight ounces of water, strained, and mixed with an equal volume of a ten per cent. solution of potassium bichromate. Either one of the formulæ we give will yield satisfactory results.

There is a little artifice which may be mentioned in conclusion as capable of bringing about an excellent range of gradation in these prints, although yielding reversed pictures. This is to print from the back of the paper, using a thin, translucent, and hard material. A smooth-surfaced paper and a thicker film of the sensitive

material may be employed if this method of printing be resorted to

The Artigue Process

This method is really a process of gum-bichromate printing on paper which is sold ready coated with gum and pigment, the latter being dead black in colour and exceptionally fine The paper is made by M Artigue, but a product closely resembling his can be prepared as follows

Smooth paper is floated on a four per cent solution of gelatine at a temperature of 80° Fahr, and then laid (the gelatined side upwards) on a sheet of glass and allowed to set An alternative and better plan is to damp the sheet of paper, squeegee it down upon a glass plate, and then coat as evenly as possible with a one and a half or two per cent cold solution of gelatine When the film of gelatine has just set, the paper is ready for pigmentation A dusting box such as is used in photogravure should be requisitioned for this purpose The box, which is large enough to take in the whole sheet of paper that is to be treated without curling, is mounted on a horizontal axle, so that, as it is rotated, a small quantity of finely-powdered pigment contained in it may be caused to drop from side to side, thus making a dust which permeates the air within the box for some time and slowly settles Now, having thrown some finely-

powdered colour into the box, it is revolved somewhat slowly, while the sides are knocked to dislodge adhering lumps. The box is allowed to rest for ten seconds, and the glass plate bearing the damp gelatinised paper is then inserted and the suspended dust allowed to settle on it for about five minutes. At the end of that time, the whole surface of the gelatined paper should be uniformly coloured by the deposited pigment. The dusting operation, however, may be repeated once or more than once if necessary. Then the pigmented paper is to be allowed to dry, in which state it will keep indefinitely.

To sensitise the paper, potassium bichromate solution may be applied to the back with a broad brush; or, preferably, it may be floated with the back, not the film, side downwards, on a five per cent. solution of bichromate (that is, a solution of one ounce to the pint). Care is to be taken that none of the solution is permitted to flow over the gelatine and pigment forming the film side of the printing paper. After saturation with bichromate solution by floating, the paper is removed from the sensitising bath and fixed with drawing-pins to a wooden frame, so that the air shall have free access to the lower (pigmented) surface. Needless to say, these operations should be performed in a subdued light. When dry, the paper is of about three times the sensitiveness of

silver P.O.P.—that is, more sensitive than ordinary carbon paper—a fact which is explained by the loose mechanical connection of the pigment particles with the gelatine of the bichromated film.

Printing has to be done, as in the regular carbon process, with the aid of an actinometer. When it is judged to be complete the print is fixed by means of wooden clips to a flat board, and developed by pouring on the pigmented surface a thick mixture of fine sawdust (fir or boxwood sawdust is the best) with water heated to about 90° Fahr. This developing "solution" may be conveniently made up in an ordinary coffee-pot, and poured from the spout over different parts of the print as local progress in development seems to indicate; and to clear off the sawdust for the purpose of examining the print a cupful of water warmed to the same temperature may be used. The abrading action of the sawdust tears away particles of colouring matter from those parts of the gelatine which were not rendered insoluble by light; and its developing power can be varied by altering the temperature and thickness of the mixture. The hotter and thicker it is, the more quickly will development take place. Local control in development is obtained in this way, a convenient plan being to commence with a thin mixture at about [illegible]° Fahr., and the process is con-

cluded by drenching or spraying the print with cold water, which hardens the gelatine while washing away any adherent sawdust. Finally, an alum bath is employed for toughening the film, this procedure being the same as in ordinary carbon printing.

Subject to obvious slight modifications, this method is, like the gum-bichromate, applicable to surfaces of other material than paper.

CHAPTER XIV

The Chemistry of the Carbon Process

The photochemical action upon which carbon printing is based is one of the kind known as reduction. The effect of light, under suitable circumstances, is to break up the complex molecules or particles of potassium bichromate ($K_2Cr_2O_2$) into simpler molecules of potassium chromate ($K_2Cr_2O_2$) and green chromium sesquioxide (Cr_2O_2).

The decomposition of two molecules of bichromate in this way results in the production of two molecules of chromate, one molecule of sesquioxide, and one molecule of ozone (O_3). Heat serves to bring about precisely the same decomposition of potassium bichromate. This can be seen by heating a crystal of the salt to redness on a piece of platinum foil, when it will flare up owing to the liberation of oxygen, and a green mass will remain, from which the chromate (soluble in water) and the sesquioxide (insoluble) can readily be separated.

If we write the chemical formula of potassium bichromate thus, $K_2O(CrO_3)_2$, and that of chromate thus, $K_2OCr_2O_3$, it becomes clear that the effect of light is the

reduction of a salt of the acid chromic oxide, CrO_3, to one of the basic oxide, Cr_2O_3.

A noteworthy fact is that the tendency of light to reduce potassium bichromate is only effective in the presence of what is called a sensitiser—that is, a body capable of exerting attraction upon one of the decomposition products of the shattered salt. The ozone has more active chemical affinities than either of the other decomposition products of bichromate, and it is towards this substance that attraction is exerted by the "sensitiser" in carbon printing. The sensitiser referred to is none other than the gelatine or like substance constituting the binding materials of the pigmented film. Gum, albumen, sugar, and glycerine each possesses an affinity for ozone as gelatine does; and all of them have been used in one or another form of the pigment printing process. But besides having such an attraction for ozone as makes possible the decomposition by light of an alkaline bichromate, the gelatine or gum which forms the bulk of the film is rendered insoluble by the oxidising process; and, of course, that secondary effect is the all-important one in this method of photographic printing.

The basic chromium oxide that is formed when sensitive carbon tissue is exposed is an insoluble salt—and a perfectly stable

one It therefore remains, together with the pigment forming the image and agglomerated by oxidised gelatine, after development has taken place The hot water that is the developing agent carries away all the unoxidised gelatine and the accompanying unaltered bichromate, also the chromate, which is a product of the action of light That a light brown image of the sesquioxide is formed in consequence of the reactions described can be easily shown by soaking any piece of sized paper in the bichromate sensitising baths, drying, and exposing to light under a negative, but, of course, this faint image is commonly quite masked by the dark colour of the carbon or other pigment suspended in the gelatine film of carbon tissue

Carbon printing proper, gum-bichromate, and the artigue process all depend upon the oxidisation of an organic "colloid," or amorphous and glutinous substance, and so, indeed, does the ozotype process also, but here the oxidising effect is produced indirectly instead of directly by the action of light The printing paper is impregnated with manganous sulphate ($MnSO_4$), which is a pink crystalline salt, together with potassium bichromate, and this manganous salt acts the part of sensitiser in place of gelatine, for it similarly attracts the oxygen liberated in photo-decomposition of the alkaline bichromate, and becomes thereby

converted into a manganic compound, which in turn gives up its excess of oxygen to the carbon tissue applied in the process of pigmentation. The addition of hydroquinone is made in this process, because that substance has a strong tanning property in the presence of oxygen, thus toughening the gelatine which forms the image and enabling it better to withstand rough treatment with hot water.

It may be added that chromic acid (H_2CrO_4) can be substituted for the acid potassium salt in the ozotype process. In sensitising the tissue for regular carbon work, either one of the trichromates, or ammonium, sodium, or lithium bichromate, or neutral ammonium chromate, can be employed. Various additions to the sensitising bath have been recommended as improvements; but, excepting the addition of a little alkali to neutralise the free acid present in an inferior sample of bichromate, these do not call for mention here, as their effects are practically negligible.

Upon this subject, perhaps it may be well to quote Professor Namias, who, in a special article in *Photography* of November 28th, 1901, discussed the action of chromates and bichromates on gelatine and gum very fully. He said there that the power of rendering colloid bodies insoluble after exposure to light which is possessed by alkaline chromates and bichromates is

due, it is certain, both to the partial reduction of the chromate or bichromate to a salt of chromium (chromium chromate), which combines with the colloid, giving as a result insoluble compounds, and also to the oxidisation of the colloids, which are thereby transformed into other compounds less soluble. That this oxidising action is an important factor may be gathered from the case of gum arabic. Gum arabic is only rendered incompletely insoluble by chromium chromate, although in the presence of a bichromate and after exposure to light it is rendered almost entirely insoluble.

The chromium salt which is formed upon exposure to light, and helps to render the colloid insoluble, is certainly not chromium oxide, for one reason, because of its insolubility which would prevent it from acting. The action must be attributed to more or less basic chromium chromate which forms. Neutral chromium chromate has a composition which corresponds to the formula, $Cr_2O_3.3CrO_3$. Of basic chromates there are quite a number. One which seems to be well defined is $Cr_2O_3.CrO_3$, which is sometimes written with the simplified formula, CrO_2.

Upon the substitution of ammonium bichromate for potassium, Professor Namias says that while the relative quantity of the two salts, which are chemically corre-

spondent, are 116 of the first to 100 of the second, if one employs the two bichromates in these proportions it is found at once that the ammonium bichromate has a quicker and more powerful action.

This is easily explained when it is borne in mind that in the case of ammonium bichromate all the chromium present is effective, while in the case of potassium bichromate only that is active which is in the condition of chromic anhydride. Now, I would remind my readers that the bichromates can be considered as a combination of neutral chromate with chromic anhydride. Thus, one can write the formulæ of the two bichromates in the following manner:

$K_2 Cr O_4, Cr O_3.$	$(NH_4)_2 Cr O_4, Cr O_3.$
Potassium bichromate.	Ammonium bichromate

Now, the neutral potassium chromate in the presence of a colloid is almost unaffected by light, for the tendency to decompose into potassium oxide and chromic anhydride is at a minimum. This is because the potassium oxide which forms—which remains present—tends to prevent by its presence the continuation of the decomposition of the chromate itself. In the case of neutral ammonium chromate, on the contrary, the alkali, being volatile, easily and quickly disappears, and so the process of decomposition goes on right up to the end.

This is shown in the following equation, the chromic anhydride which is set at liberty acting by oxidising organic matter which is present

$$\begin{array}{cccccccc} (NH_4)_2CrO_4 & = & H_2O & + & 2NH_3 & + & CrO_3 \\ \left.\begin{array}{c}\text{Neutral ammonium}\\ \text{chromate}\end{array}\right\} & = & \text{water} & + & \text{ammonia} & + & \begin{array}{c}\text{chromic}\\ \text{anhydride}\end{array} \end{array}$$

This may be put in other words by saying that in the case of the decomposition of a body by light, the sensitiveness of the compound is governed not merely by the quality inherent in the compound itself, but also by the greater or less facilities which are afforded for the getting rid of one of the products of the decomposition It follows that ammonium bichromate can undergo reduction to a much greater extent than potassium bichromate, and it is therefore necessary to employ a much greater quantity of the latter to obtain the same effect in an equal or even in a longer time

The addition of ammonia to the bichromate solution is useful in certain cases, but not in all It has the effect of changing the bichromate to the neutral chromate When added to a solution of potassium bichromate, the addition of ammonia acts by transforming it into a mixture of the two neutral chromates of potassium and of ammonium, of which the latter alone, as I have already said, is effective With ammonium bichromate, the addition of ammonia gives only neutral ammonium chromate, which is very active Neutral am-

monium chromate acts in a less active manner than the bichromates It will therefore generally be found convenient, when it is proposed to neutralise the bichromate, to employ ammonium and not potassium bichromate, in order not to diminish the action too much

The addition of ammonia to a bichromate solution ought to be made in such a manner as to change the orange yellow colour of the liquid to a citron yellow, and it is a good thing to make it until the mixture smells of ammonia This excess of ammonia has no injurious influence, for as the film dries the ammonia volatilises

But if it is proposed only to transform a part of the bichromate into neutral chromate, it is not advisable to follow the method so often recommended in formulæ, of adding a stated volume of liquor ammonia thereto Ammonia solution is so variable in strength that such a method can only be adopted with the hope of obtaining uniform results by making an elaborate calculation, taking for its basis the actual weight of ammonia gas contained in the particular solution which is being used at the moment It is a much more simple plan to divide the bichromate solution into two equal or unequal parts, as the case may be, into one of which sufficient ammonia solution is poured just to change the orange colour completely to yellow without ex-

...int but very slightly, and ...ix the two solutions. In this way ...tain bichromate solutions which, with colloids in the presence of ...play an energy which is inter-... between that of the pure solutions ...omate and that of neutral am-... bichromate.

...be noted that the partial or total ...tion of bichromate with am-... particularly useful in the case of ...loid bodies which tend to become ... by the action of acids, as for ... with albumen.

...king up solutions or preparations ...ren with bichromate it is always ...dd an excess of ammonia. Solu-... obtained in that way which keep ... several months, whereas without ...ion of ammonia the solution keeps ...ly for a very short time, and ...is employed at once it often pro-... the dried film a partial insolubility ...exposure. But in the ... pro-... addition of ammonia to the mix-... bichromate and fish glue is not ... since it makes a film that is less ... and one which tends more easily ...me detached from its support. ...e, when a mixture of fish glue with ...lbumen is employed, it is well not ... ammonia to neutralise the bichro-... in doing, I have found that when

the sensitive mixture is to be used after it has been made for two or three days, there need be no fear of the trouble that would be likely to occur if albumen by itself were being used

The employment of neutralised bichromate, on the other hand, is an advantage in sensitising carbon tissue, when it is to be kept for as long as possible, because the ammonium chromate acts in a slower manner, not only when exposed to light, but in the reaction which goes on in the tissue when it is kept from the light Preparations of gum arabic also keep much longer if they are sensitised with a bichromate solution to which ammonia has been added

Bichromates which have been transformed into chromates by the addition of ammonia have still another advantage, which renders them preferable in certain cases They are much more soluble For example, one can prepare solutions having a concentration of as much as twenty-five per cent, while with potassium bichromate, according to the season, one can only obtain from eight to ten per cent. solutions, and with ammonium bichromate twelve to fifteen per cent The great solubility of neutral chromates does away entirely with the fear of invisible crystallisations taking place in the film of gelatine, gum, or albumen, as can easily be shown with ammonium bichromate, and still more easily with potassium bichromate

One colloid body which, so far as I know, has not yet been experimented with to any extent, is a mixture of chromate and casein. A solution of casein in ammonia or in borax may be made, and a solution of ammonium bichromate, neutralised with ammonia, added to it. In this way, a solution is obtained which, after filtering, may be spread upon paper or glass, and gives a film insoluble in water, but soluble in alkaline solutions. After exposure to light, the film becomes insoluble in alkaline solutions also.

Before leaving this subject, I would like to point out an experiment which I made recently, which may help to show how complex is the action which the bichromates produce on colloid bodies in the presence of light. I took a ten per cent solution of ammonium bichromate, added to it a little glucose, and heated it for a long time in a covered vessel. The yellow liquid became a very marked brown, on account of reduction of the glucose, brought about by the heat. One may take it that under these conditions, a product is obtained resembling to some extent that which forms under the action of light upon bichromate in the presence of organic matter. On the other hand, it may be pointed out that the resulting solution only has a very slight action in rendering gelatine insoluble.

CHAPTER XV

HISTORY AND BIBLIOGRAPHY

Having described those processes of pigment printing which are most in use at the present day, it will be well to indicate a few connecting links between them in point of time, and to name those dates which fix the development of the carbon process as a matter of photographic history We will do so quite briefly, however, as we have only practical ends in view, and the historical documents which might be quoted find a more appropriate place in works of larger pretension

In 1832, Dr Tuckow, of Jena, announced that potassium bichromate when in contact with organic matter is reduced by the action of light

In 1839, Mungo Ponton discovered that bichromated paper was sensitive to light, yielding a brown image

In 1840, Becquerel, using paper that had been strongly sized with starch and sensitised with bichromate, developed a blue image by treating the exposed print with tincture of iodine

In 1853, Fox Talbot published a process of photo-engraving on steel, in which for the first time the all-important action of light in rendering chromatised gelatine insoluble was indicated and made of use

In 1855 the impregnation of bichromated gelatine with pigment or colouring matter was suggested by Poitevin His developed prints were lacking in half-tones, however, owing to that portion of the pigmented gelatine which was to be dissolved out being situated beneath the insoluble details of the image

In 1857 the powder process was devised by Beauregard

In 1858 a modification of the Poitevin process by Pouncy is still worked under the name of gum-bichromate

In 1858 both J C Burnett and the Abbé Labordi pointed out the cause of the loss of half-tone in Poitevin's process The former suggested printing through the back of the tissue to overcome it

In 1860, Fargier made two highly-important suggestions for overcoming the difficulty In the first place, he proposed to print through the paper support, instead of exposing the face of the chromatised and pigmented film, as is usual In the second place, he devised a transfer process, the sensitive film, after exposure from the front, being coated with collodion, and then, in course of development with warm

water, floated off the original paper support and deposited upon a fresh one The delicacy of the manipulations required in this first transfer process hindered its adoption

In 1864, Swan published the suggestion to employ a tough film of paper as temporary support in place of Fargier's delicate collodion film Swan's process of single and double transfer has been improved in detail by himself and others engaged in the commercial production of carbon tissues, but in all essentials it corresponds to the permanent printing process generally used to-day

The following list includes the chief text-books relating to the theory and practice of carbon printing

"Photographie au Charbon" Despagues, Paris 1866

"Production of Photographs in Pigments" Simpson, London 1867

"Der Photographische Kohle-Druck" Liesegang, Berlin 1868

"Fotografia alle Polveri Indelebili" Borlinetta, Padua 1869

"Photographie au Charbon" Vidal, Paris 1869

"La Fotografia al Carbone" Montagna, Milan 1869

"Sulle Applicazióni dei Bichromato Potassico" Borlinetta, Padua 1869

"Traité de Photographie au Charbon" Monckhoven, Paris 1876

"Historique du Procédé au Charbon" Monckhoven, Paris 1876

"Traité pratique de Photographie au Charbon" Vidal, Paris 1877

"Instructions sur l'Emploi du Papier au Charbon" Lamy, Paris, 1878

"Manual of the Carbon Process" Liesegang, London 1878

"Traité de la Photographie au Charbon" Aubert, Paris 1878

"Neber die Reactionen der Chromsaure und der Chromate auf Gelatine" Eder, Vienna 1878

"Fotantuacografia" Sobacchi, Milan 1879

"Der Kohle-Druck" Liesegang, Dusseldorf 1889

"Applications Nouvelles de la Photographie au Charbon" Engel-Feitknecht, Douanne 1891

"Carbon Printing" Bölte, New York 1893

"The A B C Guide to Autotype Permanent Photography" Sawyer, London 1893

"Carbon Printing" Wall, London 1894

"Der Gummidruck" Gaedicke, Berlin 1898

"La Gomme Bichromatée" Naudet, Paris 1899

"La Photographie au Charbon" Leibert, Paris

"Das Photographische pigment-Verfahren oder der Kohle-Druck." Vogel und Sawyer, Berlin.

"The Carbon Process." *Photo Miniature*, New York. 1900.